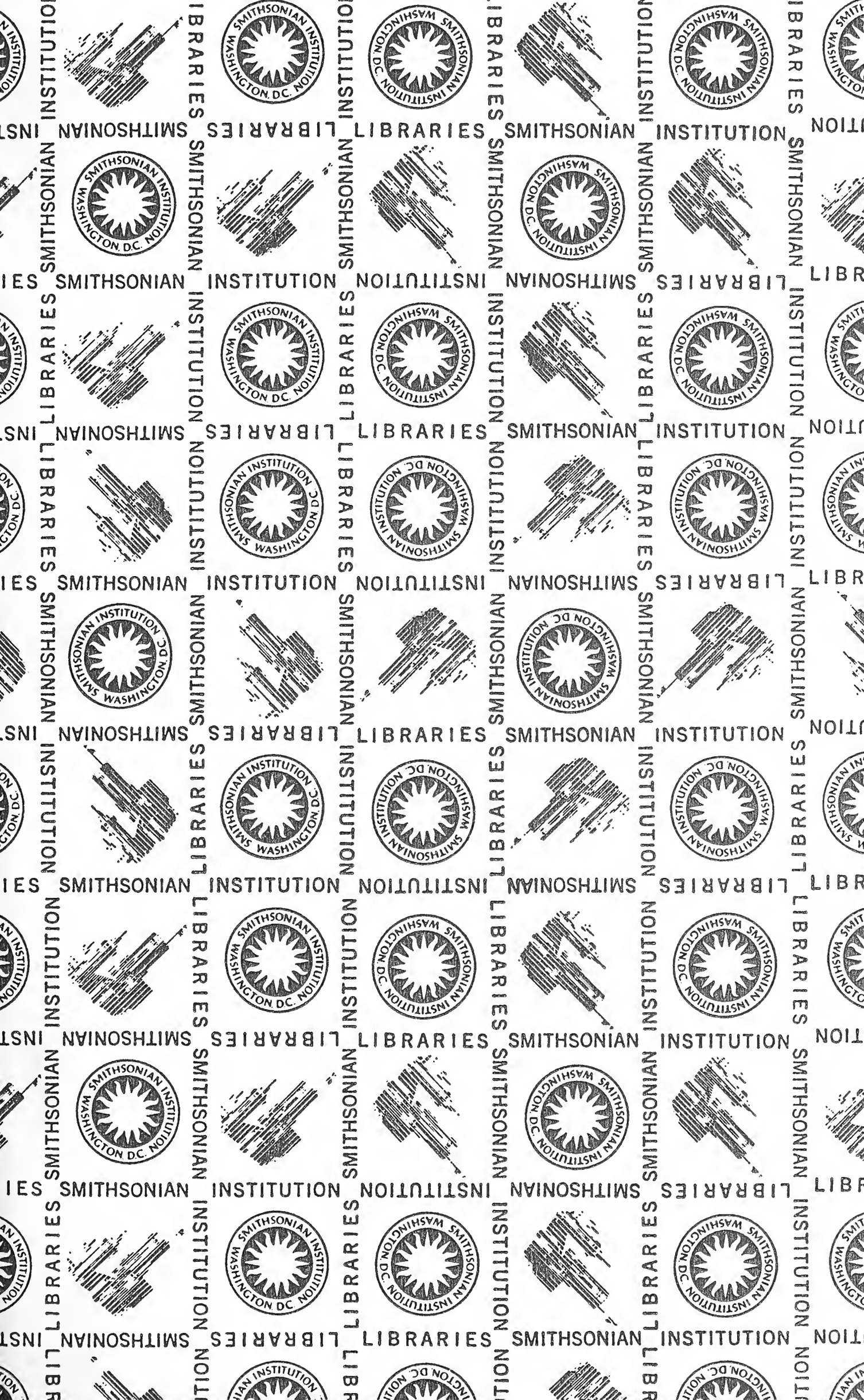
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Contents of Volume 41

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Contents

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Front cover: A branch of *Hamamelis* 'Arnold Promise' in bloom, the most outstanding witch hazel on the arboretum's grounds. Photograph by A. Bussewitz.

Growth Patterns in Woody Plants with Examples from the Genus *Viburnum*

by Michael Donoghue

Scientific journals are full of information obtained at the current limits of human perception. Using instruments like the electron microscope, biologists examine the structure of very small objects while astronomers, using extraordinarily complicated technology, can tell us details about the structure of the universe. All of this may give the impression that scientists have already observed and understood everything that can be seen with the naked eye. In botany, at least, nothing could be further from the truth. As Peter Raven (1976) has made painfully clear, we know virtually nothing about most plants, especially those that grow in the tropics. There are still many things we can learn just by *looking* at plants closely (Tomlinson, 1964).

One thing that botanists know surprisingly little about is why and how it is that woody plants (trees and shrubs) come in so many different shapes and sizes. We are all aware that elms, firs and oaks (Fig. 1), to choose only a few examples, have characteristic forms that differ radically from one another, but we seldom stop to consider what accounts for this. There are several kinds of explanations for these differences in form. One kind of explanation concerns the evolutionary causes of the differences. For example someone might "explain" that woody plants occupy a wide variety of habitats, that in

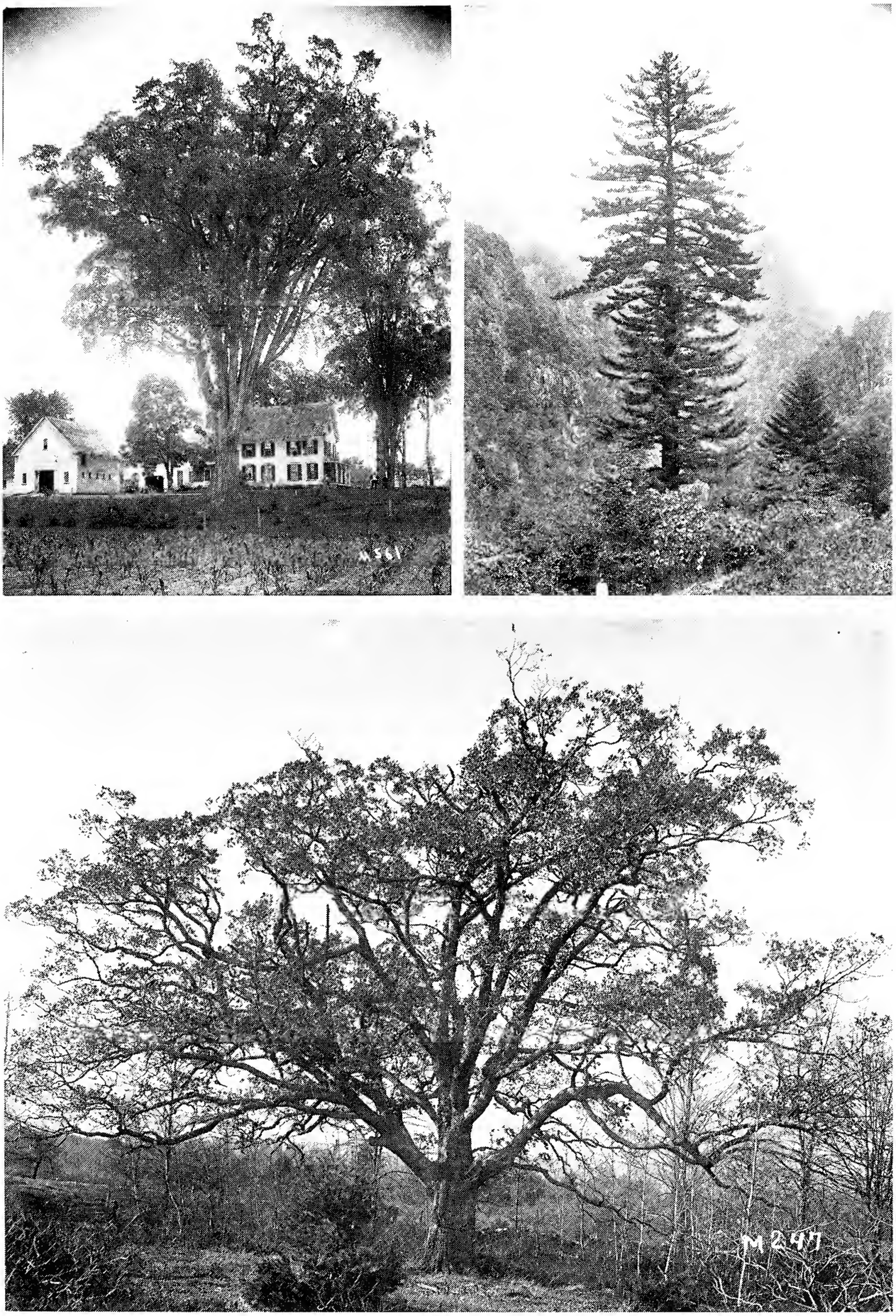

Figure 1. *These three photographs by E. H. Wilson serve as a reminder that trees come in a wide variety of shapes and sizes. The American elm* (upper left), *fir* (upper right), *and white oak* (bottom) *each has its characteristic shape, and these differ markedly from one another. These differences in shape are related to differences in growth pattern.*

different habitats particular dispositions of the leaves confer a selective advantage, and that therefore, plants with a wide variety of sizes and shapes have evolved. Another kind of explanation concerns the actual mechanisms whereby plants attain their characteristic statures. Differences in form could be "explained" solely in terms of the differing physiologies of plants, that is, in terms of hormones and their effects throughout the life of the plant. This sort of explanation is certainly not incompatible with the first kind; they are simply two ways of looking at the same problem.

In this article I want to focus attention on yet another level of explanation for plant form: growth patterns. Growth patterns of different kinds of plants vary and, at least on one level, this can account for the diversity of plant forms that we see. The study of growth patterns consists of the analysis of the number and position of a plant's meristems ("growing points") and the kinds of stems produced by them as the plant develops. New portions of stem (which bear the leaves) are added to a plant each year by the activity of its meristems which are present inside of the buds. Different kinds and amounts of new stem can be produced by such meristems. The study of growth patterns is the search for regularities in the construction of plants and the analysis of how such regularities are related to plant form.

A few botanists (DuRietz, 1931; Raunkiaer, 1934) have categorized plants according to their form or physiognomy but very little is known about the range of growth patterns in plants. This is somewhat puzzling because plant construction is relatively easy to study and one might suppose that an understanding of growth patterns would precede studies of the comparative physiology of growth or of the evolution of plant form. The reasons are in part historical. First, botanists have concentrated their efforts primarily in temperate areas and therefore have failed to see the tremendous diversity of distinctive growth patterns that occur only in the tropics. Secondly, many plants, especially those from the tropics, are known from only a handful of herbarium specimens, which may retain little information about the way that the plants were growing. A third reason is that from very early on in the study of flowering plants, interest has focused on the organs of reproduction, especially the flowers. Linnaeus' admittedly artificial classification was based on floral characters, but even in more recent systems these organs seemed to best indicate the natural relationships among plants. Finally, it has never been clear just how information about plant construction once recorded would be useful. When we have considered in more detail what a study of growth patterns involves and the kinds of information it yields, then we can consider how such studies might be of interest to plant anatomists, physiologists, ecologists, taxonomists and horticulturalists.

In 1970 Francis Hallé, a French botanist, and Roelof Oldeman, a Dutchman, introduced the idea of analyzing the form of woody plants in terms of yearly growth in their book *Essai sur l'Architecture et la*

Dynamique de Croissance des Arbres Tropicaux (not available in English until 1975). More recently, Hallé and Oldeman, along with P. B. Tomlinson of Harvard University have tried to provide a framework for the analysis of plant construction (1978). They categorized the different ways that plants grow, referring them to a number of "architectural models." Their analysis concentrates on the growth of woody plants from the time of germination to the inception of sexual reproduction, at which point a plant can be assigned to its "model." However, one need not have access to populations of seedlings and saplings to determine many things about how a plant is growing. In particular, if only mature plants are available, it is still possible to analyze the method of growth from year to year after the plants have entered their reproductive phase.

An arboretum is one of the best places to begin a study of growth patterns, especially when the living collections are sufficiently diverse and if the plants have been left relatively undisturbed so that they can exhibit their characteristic methods of growth. A study of growth patterns requires only a willingness to look closely at (sometimes with the aid of a hand lens) and accurately record (by means of line drawings and/or photographs) the growth of particular study plants throughout the year. But to do this requires a familiarity with the basic ways that plants are constructed and some understanding of what to look for. I have outlined below the sorts of features that should be examined in any study of growth patterns. I have not attempted to describe all of the ways that plants grow, but instead I've tried to introduce the basic morphological concepts that are needed in examining the growth of whole plants. For more detailed information about these concepts and for an analysis of the diversity of plant architecture, Hallé, Oldeman, and Tomlinson (1978) should be consulted.

In order to provide concrete examples of growth patterns I have included information on the growth of some viburnums. *Viburnum* is a genus of about 125 species of shrubs and trees, many of which are horticulturally important. Most of my examples concern just a few *Viburnum* species that are frequently cultivated and therefore readily available for study. The information that pertains solely to *Viburnum* is set off with smaller type. By reading the offset portion of the text, and referring to the illustrations, it should be possible to piece together the complete growth patterns for a few *Viburnum* species. These examples should make it easier to understand the study of growth patterns, while illustrating the extent to which growth pattern can vary within a group of closely related plants.

THE ELEMENTS OF GROWTH PATTERN IN WOODY PLANTS

Leaf Arrangement

One of the first things to look at when examining a woody plant is the arrangement of the leaves on the stem, that is, its **phyllotaxis.** The point of attachment of a leaf is called a **node** and the area of stem

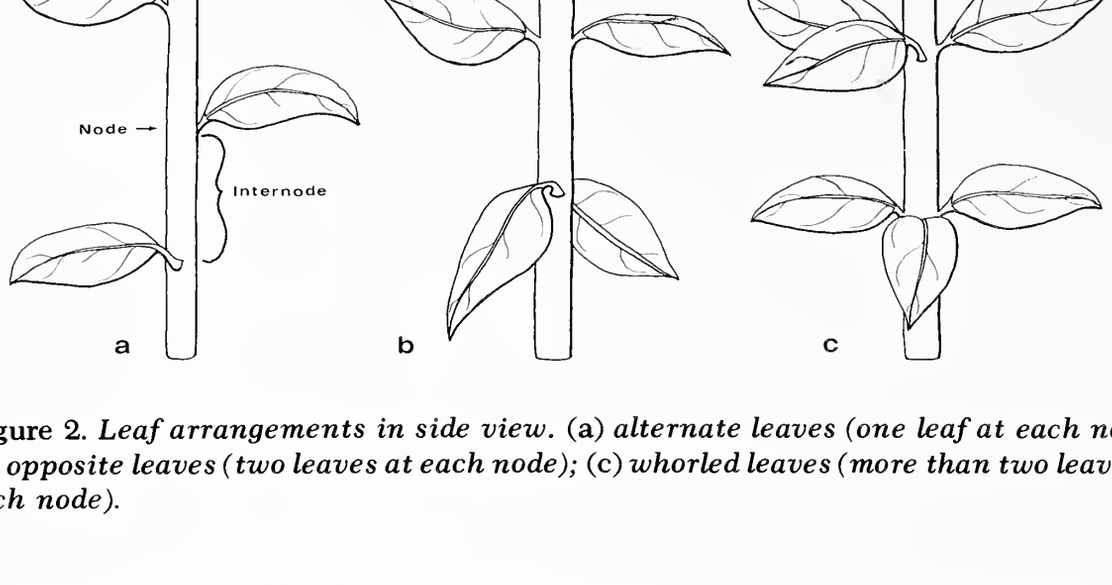

Figure 2. *Leaf arrangements in side view.* (a) *alternate leaves (one leaf at each node);* (b) *opposite leaves (two leaves at each node);* (c) *whorled leaves (more than two leaves at each node).*

between points of leaf attachment is known as an **internode** (Fig. 2a). If there is only one leaf at each area of leaf attachment, the leaves are **alternate** (Fig. 2a). If there are two leaves at each node, then the leaves are **opposite** one another on the stem (Fig. 2b), and if more than two leaves are attached at the same point along the stem, we say the leaves are **whorled** (Fig. 2c).

Another important aspect of phyllotaxis is the arrangement of the leaves around the stem when a branch is viewed end-on. In many plants with alternate leaves, the leaves are **spirally** arranged around the stem, each succeeding leaf being displaced around the stem by some relatively constant angle (Fig. 3a; Stevens, 1974). In plants with opposite leaves the leaves are often **decussate,** that is, each pair of leaves is at right angles (rotated 90°) to the pair above and below it (Fig. 3b). Some plants produce branches along which the leaves are arranged in just one plane (Fig. 3c). This so-called **distichous** arrangement can occur in plants with alternate or opposite leaves; it is most common on branches which are borne horizontally.

The arrangement of the leaves can be determined even when they are absent, such as during the winter. This can be done because when a leaf falls off, or abscises, it leaves a characteristic scar on the twig; by examining the arrangement of leaf scars, the arrangement of the leaves can be inferred.

In the genus *Viburnum* the leaves are opposite or rarely (in some Latin American species) in whorls of three. They are decussately arranged when they are first initiated but in one species, *V. plicatum* (the "double-file viburnum"), they become more or less distichous Fig. 9 due to a twisting of the internodal areas as a young horizontal branch develops.

Buds

Buds are embryonic shoots which are commonly dormant for some period of time. In the Northeast (U.S.) they are often most evident and easy to observe in the winter when they appear as "bumps" along the

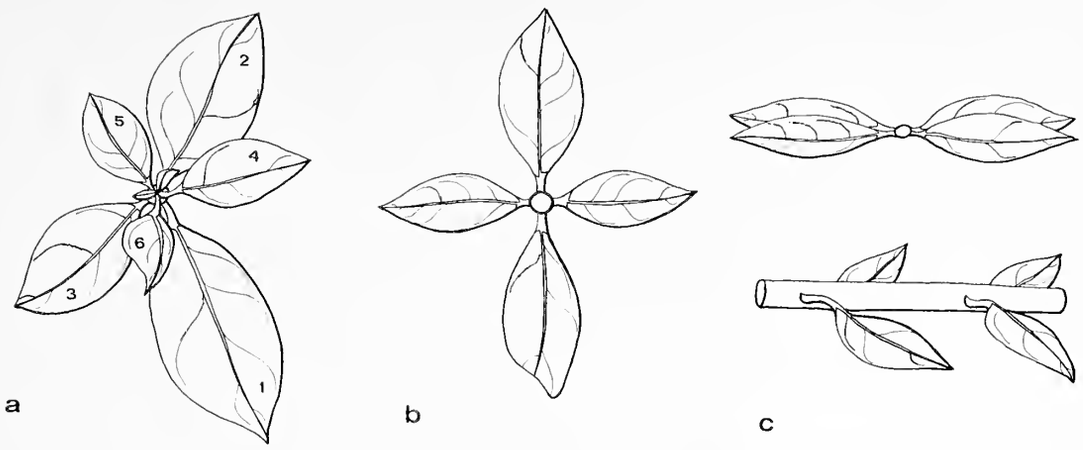

Figure 3. *Leaf arrangements viewed end-on.* (a) *spiral arrangement (the numbers indicate the relative ages of the leaves; number 1 was expanded first and number 6 was the most recent leaf to begin its growth);* (b) *decussate arrangement of opposite leaves;* (c) *distichous arrangement, the leaves borne in one plane.*

twig. A bud is commonly located in the **axil** of the leaf (or its scar), that is, on the stem just above (distal to) the point of attachment of a leaf (Fig. 4a). Such buds are called **axillary** or lateral. A bud that terminates a portion of stem and that was not produced in the axil of a leaf is said to be **terminal** (Fig. 4b). Sometimes the bud at the tip of a stem will appear to be a terminal bud. However, what actually has happened is that the apex of the stem aborted (leaving a tiny "branch" or "stem scar") and the bud was produced in the axil of the last leaf of the season (Fig. 4c). These so-called **pseudoterminal** buds can be deceptive (as in the elms, for example), so twigs must be examined very carefully to determine the exact positions of the buds.

Sometimes buds are produced in the axil of every leaf while in other cases buds may be produced only in the axils of certain leaves (e.g. the first two leaves below the shoot apex) and not in others. In some cases buds will be produced but will regularly abort in the axils of certain leaves, or buds may develop but not function (expand or produce a mature shoot) for many years. These so-called reserve buds may be released if the plant is damaged in some way.

Some plants regularly produce more than one bud in the axil of each leaf. These so-called accessory buds can be on either side of the principal axillary bud (**collateral** bud), or above it (**superposed** bud), or both (Fig. 4d, e). When this occurs, it is very important to determine the fate of the different buds. Some of the buds may produce short shoots with flowers while others produce longer vegetative shoots, and still others may remain as reserve buds.

Buds come in many shapes and sizes and are constructed in a variety of ways. In order to interpret the growth pattern of a plant it is important to understand not only the locations but also the structure of its buds. In our area many woody plants produce buds with a series of tiny leaf primordia on a shortened axis enclosed by one or a number of specialized bud scales. When these buds "break" in the spring, the scales simply fall off but their presence and position is marked on the

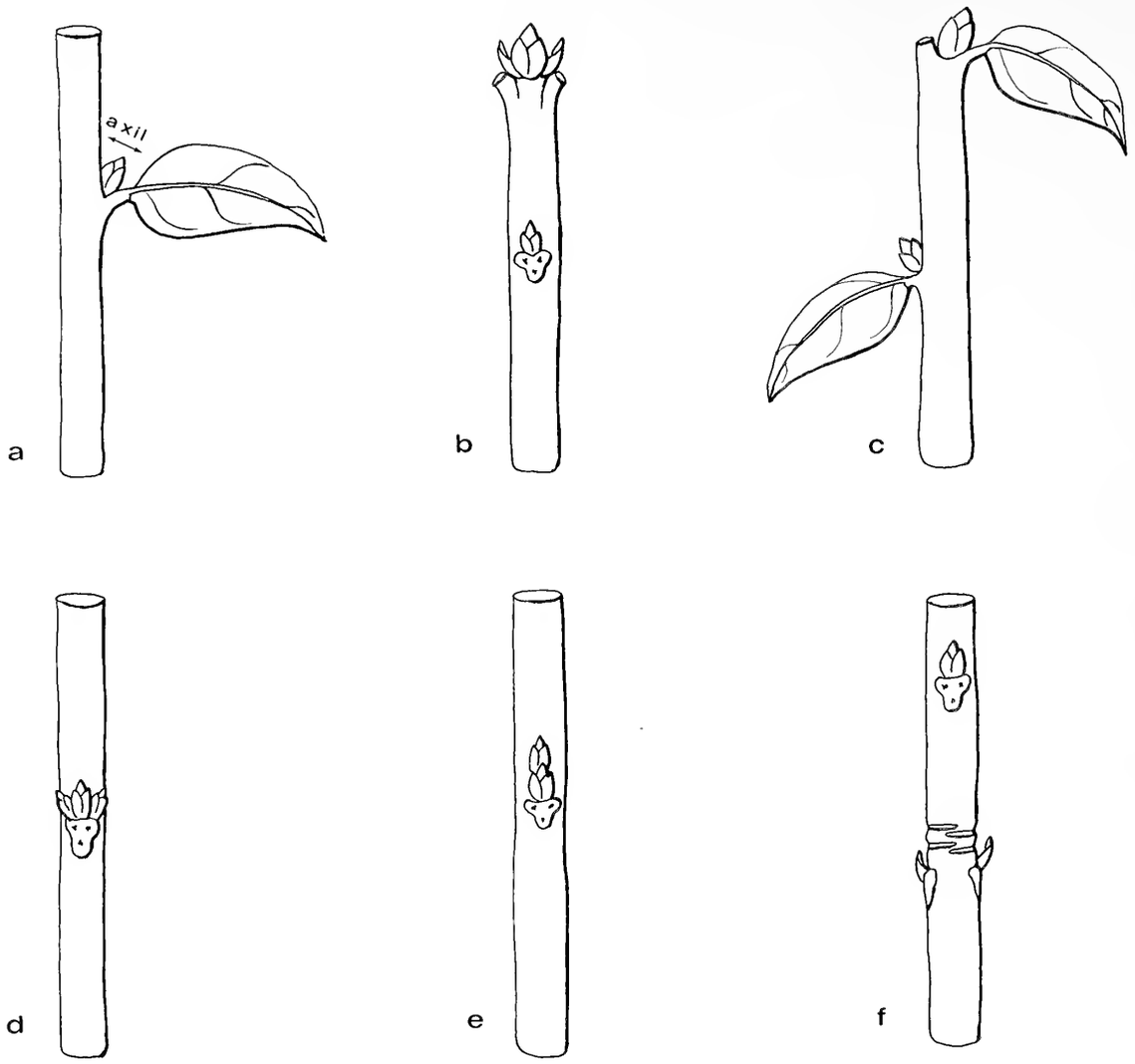

Figure 4. *Buds.* (a) *axillary or lateral buds are those produced in the axil of a leaf;* (b) *a terminal bud flanked by two lateral buds;* (c) *a pseudoterminal bud; the uppermost lateral bud appears to be terminal but the apex aborted and died back, leaving a small "branch" or "stem scar";* (d) *colateral buds flank the principal axillary bud;* (e) *a superposed bud above the principal axillary bud;* (f) *bud scale scars indicate the former presence of a bud, in this case, a terminal bud.*

twig by tiny bud scale scars (Fig. 4f). Such scars are very evident on the large twigs of the horsechestnut. This is handy for determining growth pattern because a segment of a branch can be examined and the extent and nature of the growth of each season can in most cases be assessed readily by noting the positions of the bud scale scars.

Some plants produce so-called "naked buds" which lack specialized protective scales. Instead, the outer envelopes of the bud are simply small, often very hairy, leaf primordia that will expand into the first leaves of the next season. The growth pattern of plants with naked buds is not as easy to determine as it is for those with scaly buds; it is harder to accurately assess what growth occurred during each season since the position of buds is not marked by scale scars. However, other clues, such as color and hairyness differences between the growth of different seasons, can often be used to infer the extent of a season's growth.

Figure 5. *This figure and Figure 6 illustrate the diversity of buds that occur in the genus* Viburnum. Viburnum molle (A) *and its relatives (section* Odontotinus) *have two pairs of opposite and decussate bud scales that are imbricate.* Viburnum lentago (B) *and its relatives (section* Lentago) *have only one pair of bud scales. These come together along their margins (valvate arrangement). The large, pointed terminal bud encloses the primordia of next year's leaves, inflorescence, and branches. Two lateral buds are also visible.* Viburnum plicatum (C) *likewise has only one pair of bud scales that are valvate. Pictured here is a single short shoot in winter. Note that the bud on the left (which was closest to the center of the plant) is much larger than the bud on the right. In the next season the larger one expands and repeats the growth of the previous season. In* V. × rhytidophylloides (D) *and its relatives (section* Lantana) *the buds are naked and the inflorescence is exposed during the winter. When it opens during the next season the two lateral buds will be expanding (see* Figure 15). *This plant is evergreen in our area and a small portion of a leaf blade is visible in the lower left hand corner.*

In *Viburnum* buds are very diverse (Fig. 5; 6). Plants of most *Viburnum* species produce buds with two (or rarely more) pairs of opposite and decussate scales. In some the outer pair of scales are fused along the edges as in *V. opulus* and its relatives (Fig. 6a, b) but in most species they are imbricate (overlapping each other like shingles), free from each other, and fall off separately (Fig. 5a). Sometimes the inner pair of scales will expand somewhat as the shoot develops and will appear somewhat transitional to the fully expanded leaves (Fig. 15, left). Some viburnums produce buds with only one pair of scales (e.g., *V. lentago* and its relatives) that meet along their edges without overlapping (Fig. 5b). They will often expand somewhat as the bud breaks or very rarely will expand into leaves that remain on the twig through the entire season. Other viburnums bear naked buds such as *V. lantana, V. lantanoides,* and their relatives (Fig. 5d; 6 c,d) in which the outer envelope consists of two hairy young leaves, each with inrolled edges.

Shoots

The term shoot, in its broadest sense, refers to the stem and leaves of a plant, that is, everything except the roots. In some instances, I use the term to refer to a single flush of growth (e.g., a years growth) and in other cases to the growth of more than one season (e.g., a system of branches).

Some plants produce only a single stem during their entire lifetime. This is true of many palms but some dicotyledonous flowering plants such as the papaya (*Carica papaya*) normally exhibit this kind of growth as well. On the other hand, most woody plants branch, and are therefore made up of numerous shoots.

Shoots can be classified in several ways; for example, by their orientation, relative size, and/or function. Shoots that are more or less vertical in orientation (erect or upright) and upon which the leaves are often spirally or decussately arranged (radial symmetry around the stem) are called **orthotropic.** In contrast, shoots that are more or less horizontal (parallel to the ground) in orientation and upon which the leaves are often arranged distichously (in one plane — bilateral symmetry) are called **plagiotropic.** Some shoots seem from their initiation to be intermediate in orientation, others are orthotropic but bend over or sag as the shoot system elongates with age and therefore may appear to be plagiotropic. Others, known as **mixed shoots,** begin as orthotropic and then bend over and actually become plagiotropic shoots or vice versa. All of these phenomena present problems in classifying shoots by their orientation but nevertheless, in many groups of plants, it is very helpful to consider shoots in this way. Some plants are constructed entirely of orthotropic shoots, others produce plagiotropic shoots in addition to orthotropic shoots, and still others are made up entirely of mixed shoots.

Plants of most *Viburnum* species are constructed of essentially equivalent orthotropic shoots, though these can vary in length and in whether they are

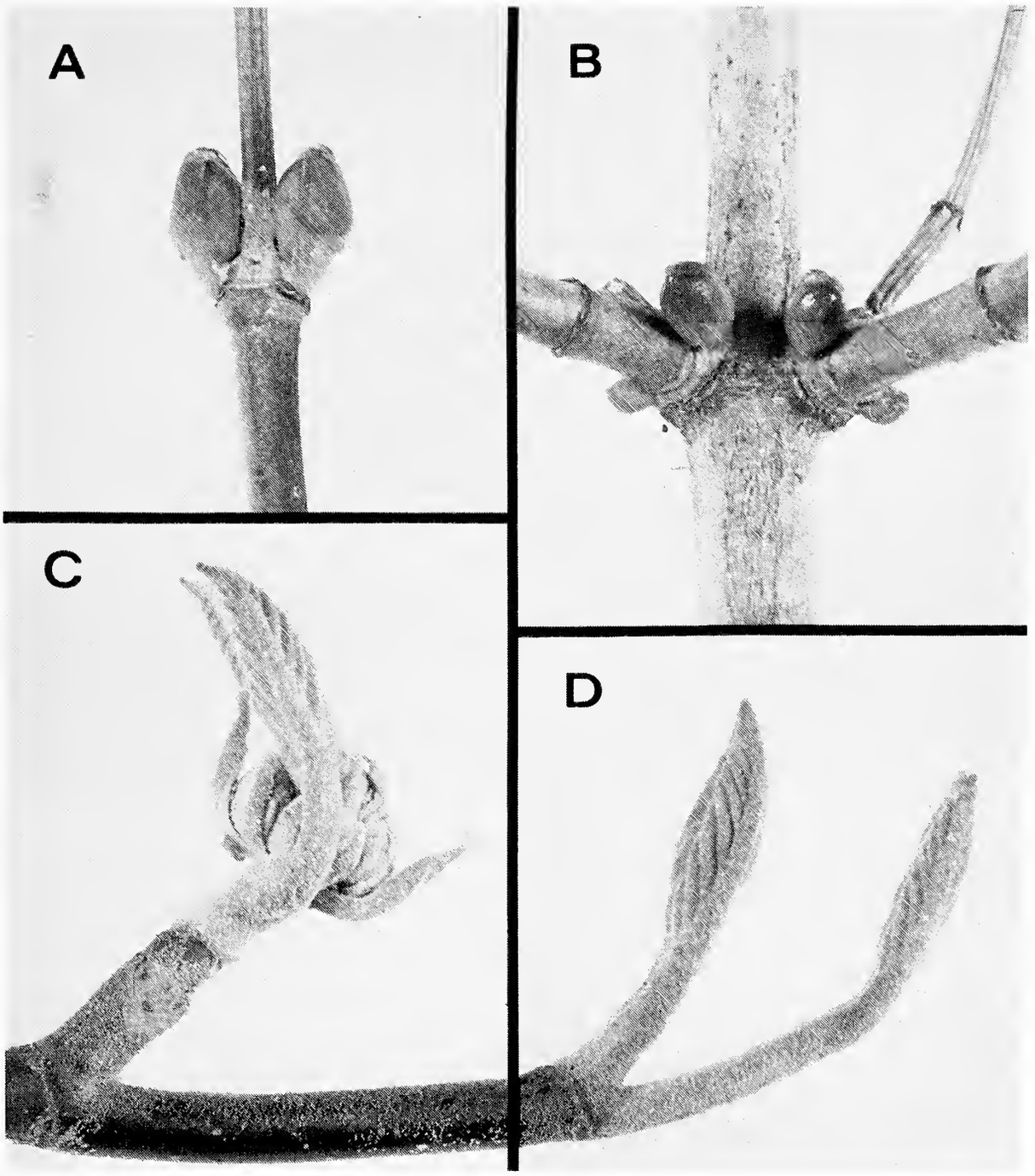

Figure 6. *More* Viburnum *buds. The highbush cranberries,* Viburnum opulus (A *and* B) *and its relatives (section* Opulus), *have two pairs of bud scales but the outer pair are fused along their margins so it appears that there is just a single envelope. The Asian* V. furcatum (C *and* D) *and its eastern North American counterpart.* V. lantanoides *have naked buds. As in the section* Lantana *the well developed inflorescences are exposed during the winter* (C).

reproductive (bear an inflorescence) in a particular year. A few *Viburnum* species (*V. plicatum; V. lantanoides* (the hobblebush, formerly *V. alnifolium*) and its Asian relative *V. furcatum*) produce an orthotropic trunk axis and plagiotropic lateral branches. The plagiotropic shoots result in plants with a very distinctive appearance, even from a distance. Egolf (1962) noted of *V. plicatum* that its "superimposed tiered horizontal branches extended to 15 feet or more" and that this results in "a spectacular pyramid shaped shrub" (Fig. 7). The growth of the plagiotropic shoots of *V. plicatum* differs from the growth of those of *V. lantanoides* and *V. furcatum* as I will detail below under a discussion of shoot growth and branching.

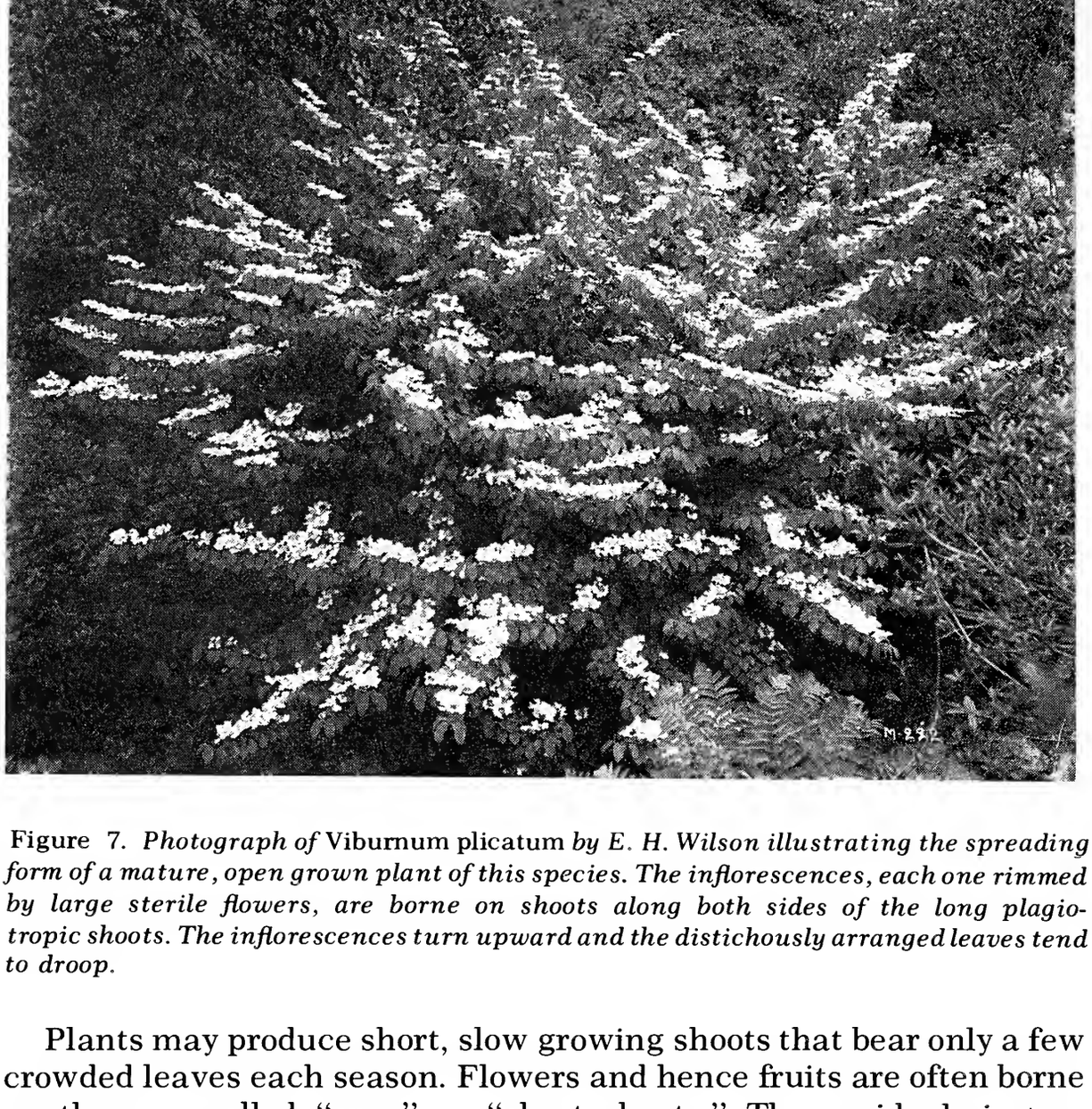

Figure 7. *Photograph of* Viburnum plicatum *by E. H. Wilson illustrating the spreading form of a mature, open grown plant of this species. The inflorescences, each one rimmed by large sterile flowers, are borne on shoots along both sides of the long plagiotropic shoots. The inflorescences turn upward and the distichously arranged leaves tend to droop.*

Plants may produce short, slow growing shoots that bear only a few crowded leaves each season. Flowers and hence fruits are often borne on these so-called "spur" or "short shoots." The maidenhair tree (*Ginkgo biloba*), the katsura tree (*Cercidophyllum japonicum*), and the apples (*Pyrus*) provide good examples of plants that regularly produce short shoots. Such shoots are usually borne laterally along a "long shoot" which has elongate internodes and a greater number of leaves per season. Sometimes a short shoot can be "released" and become a long shoot in subsequent seasons.

Most viburnums do not produce short shoots though sometimes a vegetative branch will grow very slowly and this results in crowded nodes. However, a few viburnums regularly bear their inflorescences on short lateral shoots. In *V. plicatum* the inflorescences terminate short shoots produced by lateral buds at many nodes along both sides of each plagiotropic shoot (see Fig. 9). It is because of this characteristic arrangement that *V. plicatum* is called the "double-file viburnum." A season's growth results in short shoots consisting of a pair of bud scale scars, a relatively short internode, a pair of leaves, and a stalked, terminal inflorescence that turns upwards (Fig. 5c). These short shoots can continue to grow and bear flowers in subsequent seasons. This occurs because one of the lateral buds (usually the bud closest to the center of the plant) below the inflorescence expands and produces another short shoot constructed just like the first one (Figs. 9, 10). *Viburnum farreri* (often called

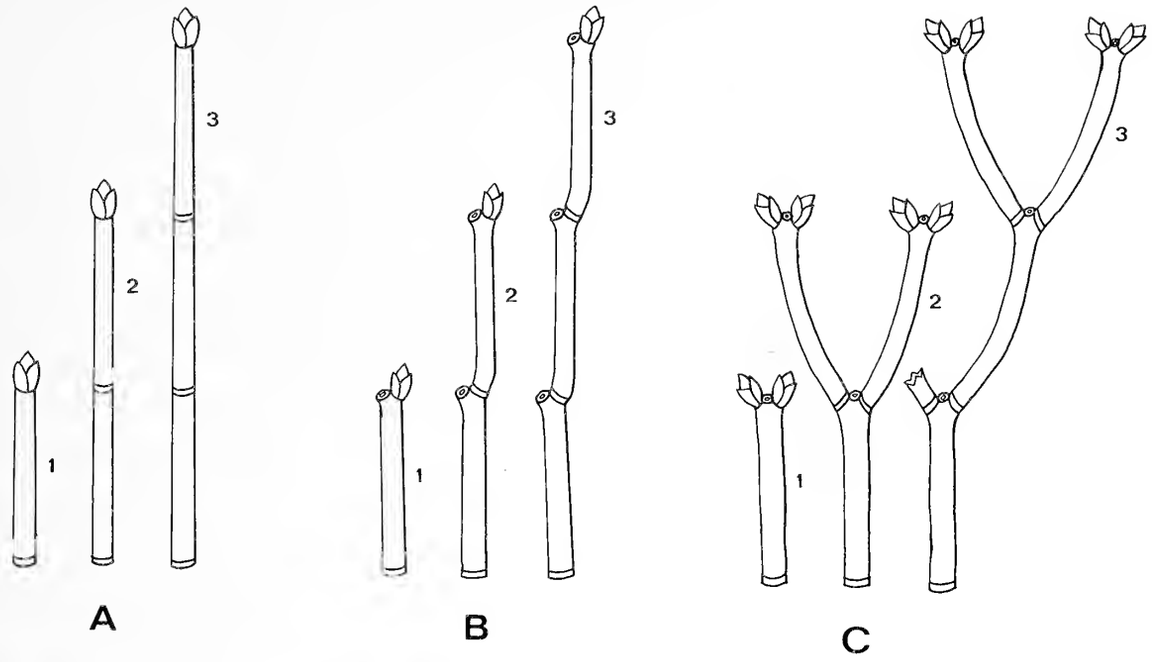

Figure 8. *Monopodial and sympodial growth.* (A) *monopodial growth (renewed growth from a terminal bud); the numbers refer to seasons of growth;* (B) *sympodial growth; successive replacement of the main axis by a pseudoterminal lateral bud;* (C) *sympodial growth; replacement of the main axis each season by two lateral buds. The latter is the most common mode of growth in* Viburnum.

V. fragrans) also produces short shoots. In our area this is the first *Viburnum* to flower in the spring and the flowers open while the plant is nearly leafless (Donoghue, 1980). Its inflorescences terminate very short, lateral segments of stem which bear two pairs of bud scales and usually a pair of leaves.

The growth of a shoot from one year to the next can occur in one of two ways. If a terminal bud is produced from which growth continues during the next season, the growth is said to be **monopodial** (Fig. 8a). If the shoot terminates in a flower or inflorescence, or if its apex aborts, or if it becomes a short shoot, then continued extension growth is possible only if one or more lateral buds grow out and replace the main axis. Successive replacement of the main axis by a lateral branch is called **sympodial** growth (Fig. 8 b,c). In some cases it may not be easy to tell whether growth is monopodial or sympodial. It is very important in this regard to determine if a bud at the tip of a branch is truly terminal or if the apex has aborted and it is a pseudoterminal lateral bud. It is also necessary to determine exactly where the flowers are produced. If a flower or inflorescence truly terminates a portion of stem (i.e., the apical meristem is completely converted into the production of flowers) then continued extension growth of the shoot is only possible if one or more lateral branches are produced. If the

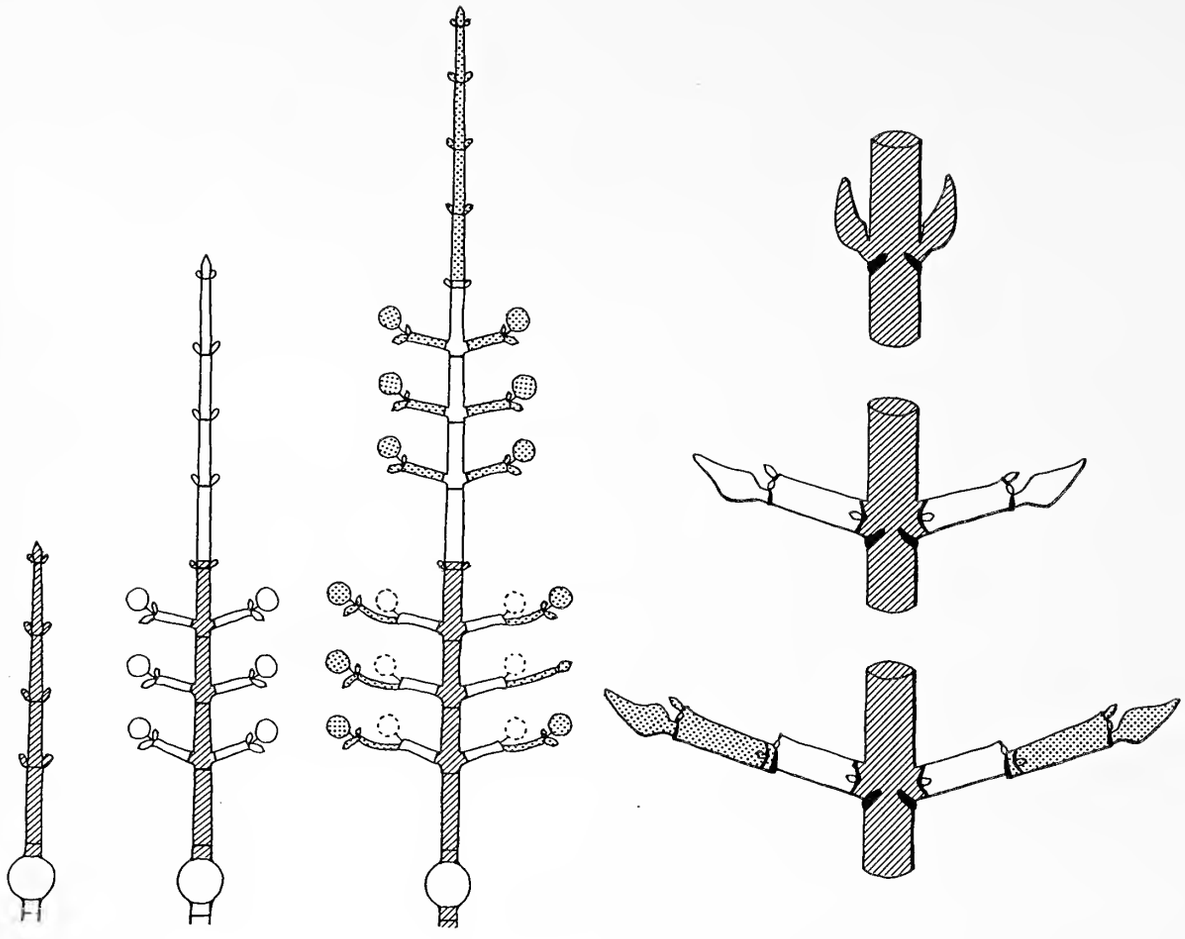

Figure 9. *The growth of a plagiotropic shoots of* Viburnum plicatum. *In this and subsequent growth pattern diagrams, the dotted portions represent the most recent flush of growth, the blank portions represent the growth of the season previous to that, and the slashed areas show the growth of three seasons past.* Right: *looking down on a plagiotropic branch, you should notice that its growth is monopodial, the buds are distichously arranged, and that the short shoots (that bear the inflorescences) are produced along each side of the main axis.* Left: *a closer look at the structure and sympodial growth of the short shoots.*

flowers are borne laterally in the axils of leaves or on short shoots, then monopodial growth of the shoot is possible.

All of the shoots of a plant need not grow in the same way. In fact, it is not uncommon for a central orthotropic trunk to exhibit monopodial growth while lateral orthotropic or plagiotropic shoots may grow sympodially. Sometimes a given axis will alternate between monopodial and sympodial growth. For instance, a shoot can grow monopodially for several years and then terminate in an inflorescence. The growth of the following season will by sympodial. Subsequent growth may be monopodial or sympodial depending on whether a terminal inflorescence is produced in a particular season.

In *Viburnum* the inflorescences are always terminal though in the few cases discussed above they are borne on short lateral shoots. This means that once a particular shoot ends in an inflorescence there must be sympodial growth for the shoot to continue to extend. However, a given shoot can extend monopodially for many seasons before entering a reproductive phase.

Viburnum plicatum and *V. lantanoides* produce both orthotropic and plagiotropic shoots. In both species the growth of the orthotropic trunk axis is

Figure 10. *The growth of* Viburnum plicatum. Left: *a terminal portion of a plagiotropic shoot from above. This picture was taken in the early spring as the buds were breaking and the new shoots were emerging. A new portion of plagiotropic shoot will be produced by the expanding terminal bud at the top of the picture. The lateral buds are developing into short shoots, each with an expanding pair of leaves and a terminal inflorescence.* Right: *A close up picture of a single short shoot that is entering its fourth season of growth. Each season the growth was terminated by an inflorescence and subsequent growth was from one of the lateral buds.*

monopodial for many years but the plagiotropic shoots of the two species differ markedly in growth. In *V. plicatum* the plagiotropic shoots grow monopodially for many years and the inflorescences are borne on the short lateral branches which are, of necessity, sympodial in growth. The tip of the plagiotropic shoot turns upwards towards the end of each season and a long-stalked lateral bud is produced which will continue the growth of the plagiotropic shoot system in the next season. The short upturned axis will bear inflorescences in subsequent seasons (Fig. 11 and Fig. 6 c,d.)

The growth of *V. opulus* (the highbush cranberry or guelder rose, including the American *V. trilobum*) is very unusual in *Viburnum* in that terminal buds are almost never produced and growth is, therefore, always sympodial. Long vegetative shoots are produced that do not end in inflorescences or in terminal buds. Instead, these shoots continue to grow well into the summer until eventually the apex of the shoot aborts and the twig dies back to the last pair of leaves that were produced. The uppermost pairs of lateral buds that were produced grow, during the next season, into shoots that terminate in inflorescences. These reproductive shoots generally die back at the end of the season and in the following year new long vegetative shoots arise from buds in the axils of the first pair of bud scales for each reproductive shoot. This method of growth is illustrated in Fig. 12 and Fig. 6 a,b.

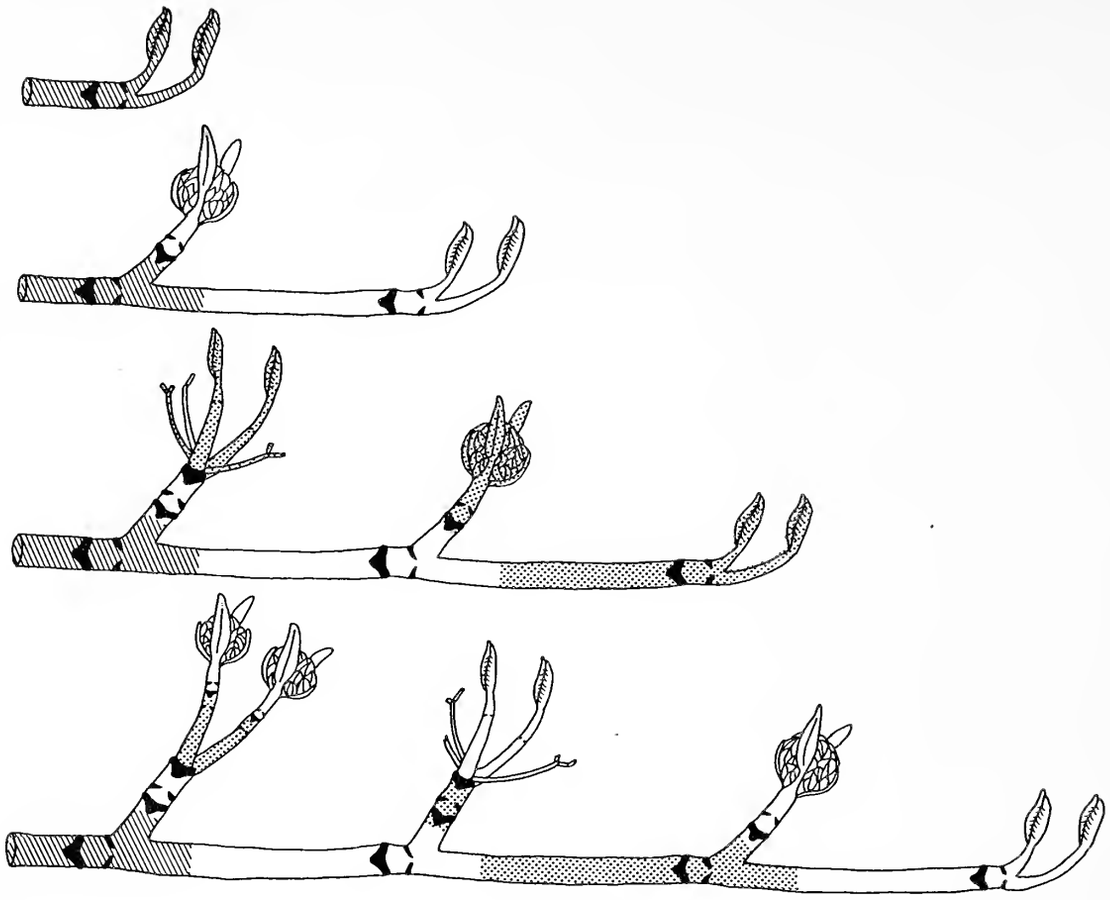

Figure 11. *The growth of a plagiotropic shoot of* Viburnum furcatum. *Four seasons of growth are shown in this diagram. The growth is sympodial; the main axis turns upward at the end of each season and it is replaced by the growth of a lateral bud, which overwinters as a stalked structure (see* Figure 6D). *Inflorescences are produced along the plagiotropic shoot on the upturned portions, which can continue to grow for many seasons. The inflorescences are well developed and exposed during the winter (see* Figure 6C).

The Timing of Growth

Some tropical plants seem to grow continuously. They exhibit no morphological evidence of dormancy in that their stems are not obviously segmented and their buds always seem to contain the same number and kinds of parts (e.g., primordial leaves). Some palms provide examples of plants that are "ever-growing" and produce leaves at a continuous rate.

Most woody plants, including all of the trees and shrubs in temperate and boreal regions, exhibit rhythmic growth, that is, periods of dormancy alternate with periods of extension growth in plants with scaly buds. The morphological indication of rhythmic growth is a more or less pronounced segmentation of the mature shoot system. In plants with naked buds it can be difficult to assess the periodicity or growth but a series of shortened internodes or smaller leaves usually indicates a slowdown or cessation of growth.

Growth in *Viburnum* is always rhythmic. In our area viburnums are dormant during the fall and winter and there is a single episode of extension

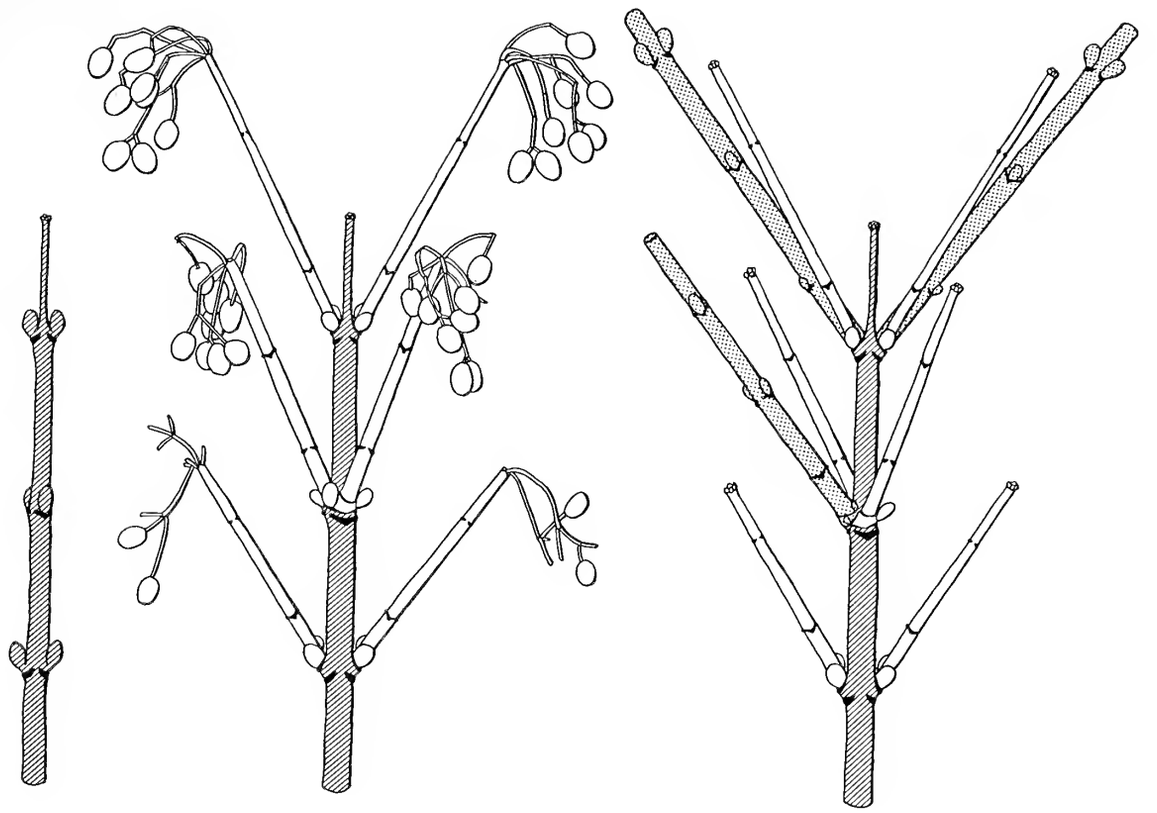

Figure 12. *The growth of* Viburnum opulus. *In this species and its relatives terminal buds are almost never produced. Long vegetative shoots abort at the apex and die back to the first pair of lateral buds (see* Figure 6A). *These buds expand to produce ephemeral shoots that bear the inflorescences. New vegetative shoots are produced from buds at the bases of these reproductive shoots (see* Figures 6B *and* 13).

Figure 13. *The growth of* Viburnum sargentii. *Plants of this species grow like* V. opulus *plants. Here, new vegetative shoots are beginning to grow from buds at the bases of last years reproductive shoots, which have persisted as dead twigs.*

growth beginning in the spring and continuing into the summer. Viburnums of mountainous regions in the tropics may undergo two or more episodes of extension growth during a particular growing season. Sometimes, in those viburnums with naked buds, growth may appear to be continuous because the stems are not obviously segmented. However, observations through the year show that they are dormant for long periods.

Branches can be classified according to the timing of their development (Tomlinson and Gill, 1973; Tomlinson, 1978). If a branch develops from a bud which has been dormant for some period of time, then it is called a **proleptic** branch. Branches which develop without any evident period of dormancy of the lateral meristem are called **sylleptic.** Often there are morphological differences between proleptic and sylleptic branches. Shoots that develop after a period of dormancy commonly bear one or more basal scales (which result in scale scars on the mature branch) and a series of foliar appendages that are transitional between bud scales and normal leaves. In contrast, sylleptic shoots usually lack basal scales and transitional appendages. Instead, the first leaves of these shoots are essentially like the leaves produced later and they are separated from the point of branch insertion by a long internode which has been called a hypopodium. Occasionally, branch morphology can be very misleading about the timing of events. A branch can have developed after dormancy but exhibit the usual morphology of sylleptic branches. This is often true of plants with naked buds because there are no bud scale scars to mark the site of a dormant bud. In some of these cases the first leaves of a branch will be small or differ in shape from subsequent leaves, or the first internodes will be shorter, but this is not always true. It is important to realize that branch morphology can provide clues to the timing of branching but to be certain, plants have to be carefully observed throughout the year.

Branching in most viburnums is strictly proleptic and usually this is clearly reflected in branch morphology. In those species with bud scales, bud scale scars make it very easy to tell when and where there was a period of dormancy. In some cases an inner pair of bud scales may be transitional in appearance to normal leaves but in most cases there is a sharp distinction and sudden change between bud scales and foliage leaves. In most of the viburnums with naked buds, branching follows a period of dormancy but the resulting shoots appear to be sylleptic on morphological grounds.

Sylleptic branching occurs sporadically in many viburnums. It is not uncommon for very vigorous, rapidly growing shoots to produce lateral branches which do not undergo an evident dormancy. In some of the viburnums with naked buds, such as *V. furcatum* (Fig. 6D), conspicuous lateral portions of stem are regularly produced without any evident period of dormancy. These do not bear any expanded leaves during the season in which they are produced and are therefore probably best considered stalked buds rather than sylleptic branches.

The timing of branching relative to the timing of flowering is often of interest and should be noted in any study of growth patterns. Many woody plants of the temperate zone have all of the primordia of the organs (e.g., leaves and flowers) that will expand in the next season preformed inside their winter buds. These buds open in the spring, leaves and inflorescences are expanded, flowering occurs, and buds are formed in the new leaf axils during the summer. The timing of these events can be shifted. In some plants the inflorescence is not preformed in the bud, but rather, is formed as the shoot is growing during the spring and summer. In some cases these inflorescences will flower and fruit during the same season that they were produced but in other cases the newly formed inflorescences will overwinter in an exposed state and flower during the next spring. Clearly, other differences in the timing of these processes are possible.

In most viburnums the inflorescences are preformed and enclosed inside of buds; branches are produced below inflorescences in the year after flowering occurs. This pattern characterizes *Viburnum dentatum* and its relatives (Fig. 14, left; 15, left). In contrast, in *V. lantana* and its relatives the inflorescences are formed during the season and over winter as well developed, exposed primordia (Fig. 5D). Then in the following spring the flowers open while at the same time proleptic branches are produced below the inflorescence (Fig. 14, right; 15, right).

One final, very important consideration is the absolute length of time that a shoot grows in a particular way, because this largely accounts for size and shape in woody plants. For example, if an orthotropic shoot continues monopodial growth for many years, a tall plant with a trunk-like axis will result. If on the other hand, the period of monopodial growth is short and is followed by the production of lateral plagiotropic shoots then the overall stature of the plant will be very different. The number of possible combinations of different amounts of different kinds of growth of different shoots is almost unlimited. There are at least as many combinations as there are differently shaped plants.

THE IMPORTANCE OF UNDERSTANDING GROWTH PATTERNS

Analyzing patterns of growth requires very little in the way of equipment or technical expertise but can provide many valuable insights. Findings in the study of growth patterns will help in assessing the overall diversity of plant morphologies and thus will clarify morphological categories such as the kinds of shoots or the types of branching in plants. This, in turn, will be of interest to anatomists studying the structure of branching points (Wheat, 1980) and to physiologists investigating the flow of water and nutrients in plants (Zimmermann, 1978).

Growth patterns can also be of interest to ecologists and evolutionary biologists since certain kinds of growth may be limited to

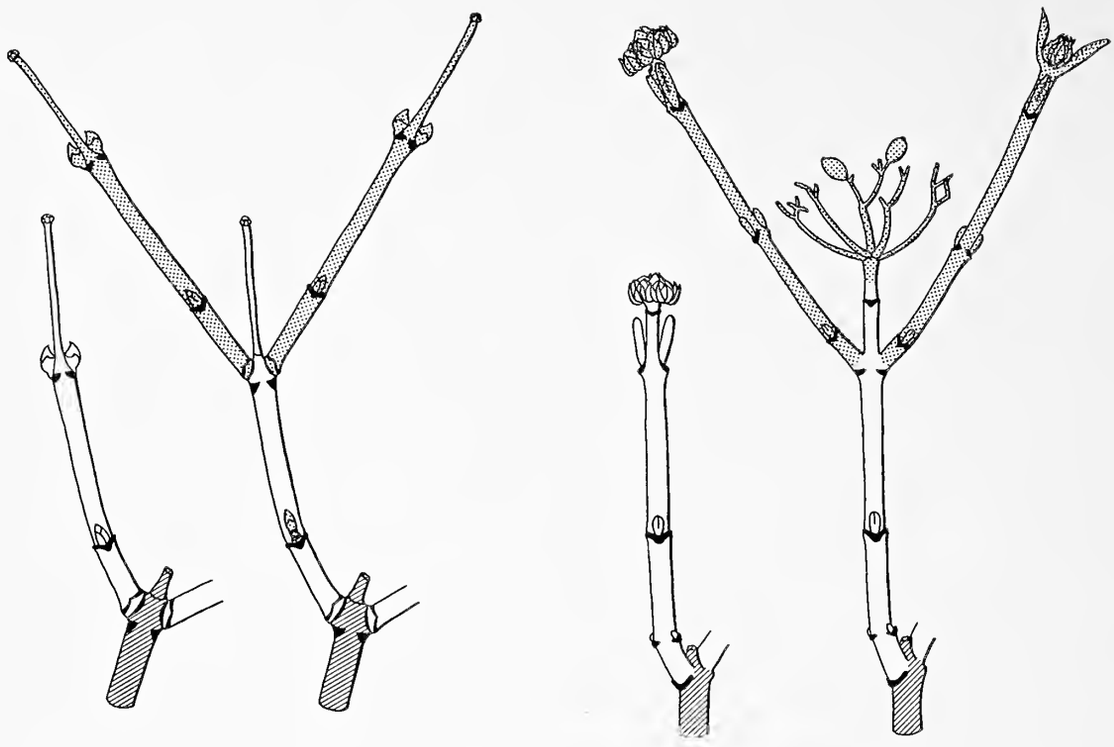

Figure 14. *Differences in the timing of inflorescence development and branch production are illustrated by the growth patterns of* Viburnum dentatum *and its relatives* (left) *and* V. lantana *and its relatives* (right).

particular habitats or certain stages in vegetational succession (Ashton, 1978; Oldeman, 1978). In addition, branching patterns, when correlated with other features such as leaf size and shape, will help us to understand the ways that plants are adapted to different light regimes (Horn, 1971; Fisher & Honda, 1979a,b). Simply understanding how plants grow from year to year may make it possible to quickly age plants and determine the extent of vegetative and reproductive effort over a number of years. A good example of this use of growth patterns is provided by the studies of Sohn and Policansky (1977) on populations of the mayapple (*Podophyllum peltatum*).

An understanding of growth patterns can be useful in agriculture and horticulture as well. It is especially important to know when and where on the plant flowers and hence fruits are produced. This knowledge along with an understanding of the physiology of growth may make it possible for plant breeders to significantly alter growth patterns so as to increase flower production and fruit yields. Landscape architects interested in plants of a certain form for particular settings should understand growth patterns and the extent to which they can vary and be altered. A clear understanding of growth pattern is required before pruning a plant to achieve a desired effect.

Finally, studies of growth pattern, in providing a variety of characters, can be of value to systematists trying to understand the relationships among plants. As Hallé, Oldeman and Tomlinson (1978) pointed out, "clouds of leaves, flowers, fruits, trichomes, and other diagnostically useful characters do not hang somewhere in the air but form part of whole organisms." However, with only a few exceptions (Fagerlind,

Figure 15. Viburnum rafinesquianum (left) *is a relative of* V. dentatum (*see* Figure 14). *Notice that the new shoots are produced in the axils of the first leaves below last years inflorescence. The buds open and the shoots expand rapidly. The inflorescences, which are still young, will open their flowers within a few weeks.* Viburnum carlesii (right) *is a relative of* V. lantana (*see* Figure 14). *Plants of these species have naked buds and they expand their lateral branches at the same time that the inflorescence on the parent axis continues its development and eventually flowers.*

1943; Lems, 1962; Petit, 1964), taxonomists have made little use of growth characters. Perhaps this is because they often work primarily with herbarium specimens and have field experience with only a few of the species that they treat. But it should be noted that it is often possible to extend an analysis of growth patterns to species that have not been studied in the field. Once some familiarity with growth patterns has been obtained with living plants, it is possible to decipher a great deal about growth by looking at herbarium specimens alone, especially when ample material is available and in groups in which the leaves and flowers are not overly large. If plant collectors were to pay more attention to growth characters the value of herbarium specimens for these purposes could be greatly increased (Ridsdale, 1975). An understanding of the diversity of growth patterns in *Viburnum* is helping me to make sense of the relationships of the species to one another. Along with other kinds of evidence growth patterns provide valuable insights into the evolution of the genus.

The elements of growth discussed above (and some that I have not discussed) can occur together in many different combinations and this results in a great diversity of growth patterns. An extensive terminology has been developed to try to encompass all of the ways that plants can grow. But nature is sufficiently complex that some situations cannot be accurately described with existing terms (Sattler, 1966).

Forcing plant growth into rigidly defined categories would only distort our perceptions of the many different ways that plants are constructed. For the present it is most important to carefully observe and accurately document the ways that plants actually grow.

Acknowledgments

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Blakea gracilis *from* Curtis' Botanical Magazine *(132 (1906): t. 8099), with insets showing details of leaf and flower structure.*

Discovering *Blakea gracilis*

by Barbara O. Epstein

Few things are more exciting to an amateur horticulturist than the discovery of a previously unfamiliar plant or species with outstanding aesthetic characteristics; particularly so when the plant turns out to be amenable to indoor cultivation. Such was the excitement I experienced when I first came upon *Blakea gracilis* early in 1978 during a visit to a commercial greenhouse in Connecticut.[1]

In the plethora of flowering specimens, one caught my eye to which I was unable to attach any sort of name. Striking in both form and flower, it was nearly four feet tall, with glossy, green foliage and single, white flowers of an almost palpable waxy texture. Evidence of what must have been a profusion of previous blossoms remained in the form of rusty red bracts. I purchased a small specimen that day and immediately began cultivating the mysterious plant in my conservatory. Three years have passed and *Blakea gracilis* has proved to be a remarkable plant.

A native of Central and South America and the Caribbean Islands, the genus *Blakea* was first described by Sir Patrick Browne in his book *The Civil and Natural History of Jamaica* (London, 1756). Browne named the plant for his patron, Martin Blake, a naturalist from Antigua who apparently supplied the funds for many of Browne's botanical expeditions. Bailey's *Standard Cyclopedia of Horticulture,* however, ascribes the name to a certain Stephen Blake, author of *Compleat Gardeners' Practices* (London, 1664). Considering that Stephen Blake is not even remotely linked with subtropical flora it seems likely

[1] Logee's Greenhouse, Danielson, Conn.

that it was Martin and not Stephen Blake whose name the genus bears.

Blakea is a member of the primarily tropical plant family Melastomataceae. The only genus of this family in our native flora is *Rhexia,* the deer grasses, several herbaceous species of which grow in New England. Although many Melastomataceae are showy and ornamental, only a few species of *Dissotis, Medinilla* and *Tibouchina* are grown under glass in New England. In his *Monograph of the Melastomataceae* published in 1891, Cogniaux describes 31 species of *Blakea.* More recently, Dr. John Wurdack, curator of the U.S. National Herbarium of the Smithsonian Institution, and a recognized authority on the Melastomataceae, reports at least 100 described species. Many of the other species are ornamental and worthy of cultivation, but only *B. gracilis* and *B. trinervia,* with larger, three-veined leaves, and larger, rose-colored flowers, appear to be available. Several of the Central American species are spectacular with 4–5 inch broad, pink flowers and very bold foliage, but these grow too large for home cultivation.

A literature search reveals that little has been written about *Blakea gracilis* since early in this century. In 1905 a specimen which flowered at Kew was described by S. A. Skan in the *Botanical Magazine* of 1906, accompanied by a line drawing. (Skan's description was later reprinted that same year in *Gardeners' Chronicle* with his name erroneously printed as "Shaw", an error perpetuated elsewhere.) Skan writes that *B. gracilis* was collected by Max Endres for the well-known nursery of James Veitch & Sons at the turn of the century. At that time it had been found in several locations in Costa Rica, growing in forests at elevations of up to 5,570 feet. Kew purchased its plant from the French nursery of Messrs. Lemoine & Sons in 1904. In February of 1905 it flowered in a greenhouse at Kew and was the object of great excitement. Skan mentions its rapid and spreading habit of growth, noting that at only a foot high it was already nearly two and a half feet across.

Dr. Richard Weaver of the Arnold arboretum staff recently collected and photographed *B. gracilis* in its native habitat in Costa Rica. It was found in the cool montane forests between 4000 and 5500 feet where rains and mists are frequent. Like other species of *Blakea, B. gracilis* is often epiphytic in the wild. It appeared to reach its best development growing on isolated trees on the slopes of the volcanoes around San José. Weaver reports one magnificent specimen which formed a skirt at least 30 feet wide around the lower canopy of a tree. Although nearly past bloom it was yet attractive because of its glossy leaves and reddish fruits, with their subtending bracts.

In indoor cultivation, a height of 2 to 3 feet can be expected, making it a fairly compact small shrub. Much branched, slender and nearly glabrous, *Blakea* presents a very appealing habit of fullness. The leaves are elliptic in outline, shiny while young, and somewhat leathery. They vary from 2½″ to 4″ in length, and up to 1¾″ in width. Prominent longitudinal veins characteristic of the Melastomataceae, are palmate and almost parallel (5 in *B. gracilis*).

A large shrub of Blakea gracilis *growing epiphytically at Las Nubes, in the mountains near San José, Costa Rica, at an elevation of 4000 feet. Photograph by R. E. Weaver, Jr.*

Photograph showing the ornamental features of Blakea gracilis: *the conspicuous buds, a flower at its peak and the glossy leaves with obvious longitudinal nerves typical of the family Melastomataceae. Photograph by P. Del Tredici.*

Plump, white buds, waxy in texture, occur in great profusion and are quite attractive. Mention is made in the *Flora of Costa Rica* (Standley, 1938) that both the flower buds and the ripe fruits of *B. gracilis* are edible. They are reported to be juicy with an agreeable, though tart flavor, although I have no first-hand experience to confirm this.

The open flowers, about a half-dollar in size, are borne singly in the leaf axils and have six petals. Most descriptions mention a faint pink blotch at the base of each petal, which I have found to be almost imperceptible. Weaver reports flowers with a prominent pink stripe along the edge of each petal, in addition to the basal blotch, on plants observed in Costa Rica. Despite a description in the *Gardeners' Chronicle* (September, 1905) that "the flower is beautifully scented, and in general appearance may be said to be like a glorified apple blossom," I have yet to detect even a hint of fragrance in three years of indoor cultivation.

Twelve stamens with short filaments and large, yellow, oblong anthers joined at the margins form a semi-circle around the slender style. The anthers dehisce by minute pores at the apex. Bracts are three-nerved and are attractive in themselves after the flowers are spent. Weaver describes the fruit as reddish, approximately 7/8" in diameter (the size of a dime), with a slight central depression.

Propagation is not difficult. It is recommended that stem cuttings with hardened growth be used for propagation in the summer. Cuttings collected recently by Dr. Weaver in Costa Rica were successfully

propagated in the arboretum's greenhouses using Hormo-root B hormone powder. Stuck in a medium of sand and perlite and placed under a polyethylene tent, they rooted in just a few months with an excellent root system. However, even cuttings made from new growth and stuck in perlite without a hormone application under lights produced a good set of roots. The medium is best kept on the dry side to prevent the possibility of stem rot. Seeds collected in Costa Rica before the fruits were quite ripe germinated well in about 3 weeks without any pretreatment. The resultant seedlings are healthy but slow-growing and they will probably take at least two years to bloom.

Culturally, I have found *Blakea* to require little care. Bailey's *Standard Cyclopedia of Horticulture* recommends an "intermediate" growing temperature (a night-time temperature of about 55°F). A standard, well-drained soil with a bit of additional peat is adequate. Although it likes a fair amount of water in spring and summer when it is actively growing, it is generally tolerant of drought.

Because of its habit of branching freely, it can become quite dense if not pinched regularly. I usually make pruning an occasion to distribute cuttings to friends who wish to begin plants of their own.

Grown as a conservatory plant, my own *Blakea* receives good light, including at least three hours of direct sun daily. In summer, *Blakea* can be kept outdoors in a lath house or in dappled sun. Although it will continue to thrive in less light, heavy bloom cannot be expected. For this reason, I am more inclined to suggest *Blakea* as a plant for a conservatory-like environment rather than the living room, a circumstance not as uncommon as it once was.

If there is a mystery that remains concerning *B. gracilis* it is why such an appealing and amenable plant is so little known and at least until now, so rarely cultivated.

Acknowledgements

The library of the Arnold Arboretum was my main source of information. I am indebted to Mr. Byron Martin of Logee's Greenhouses of Danielson, Connecticut, for his information on propagation and cultivation; thanks also to Dr. John Wurdack of the Smithsonian Institution and Lothian Lynas of the New York Botanical Garden Library for their assistance in researching the genus *Blakea*.

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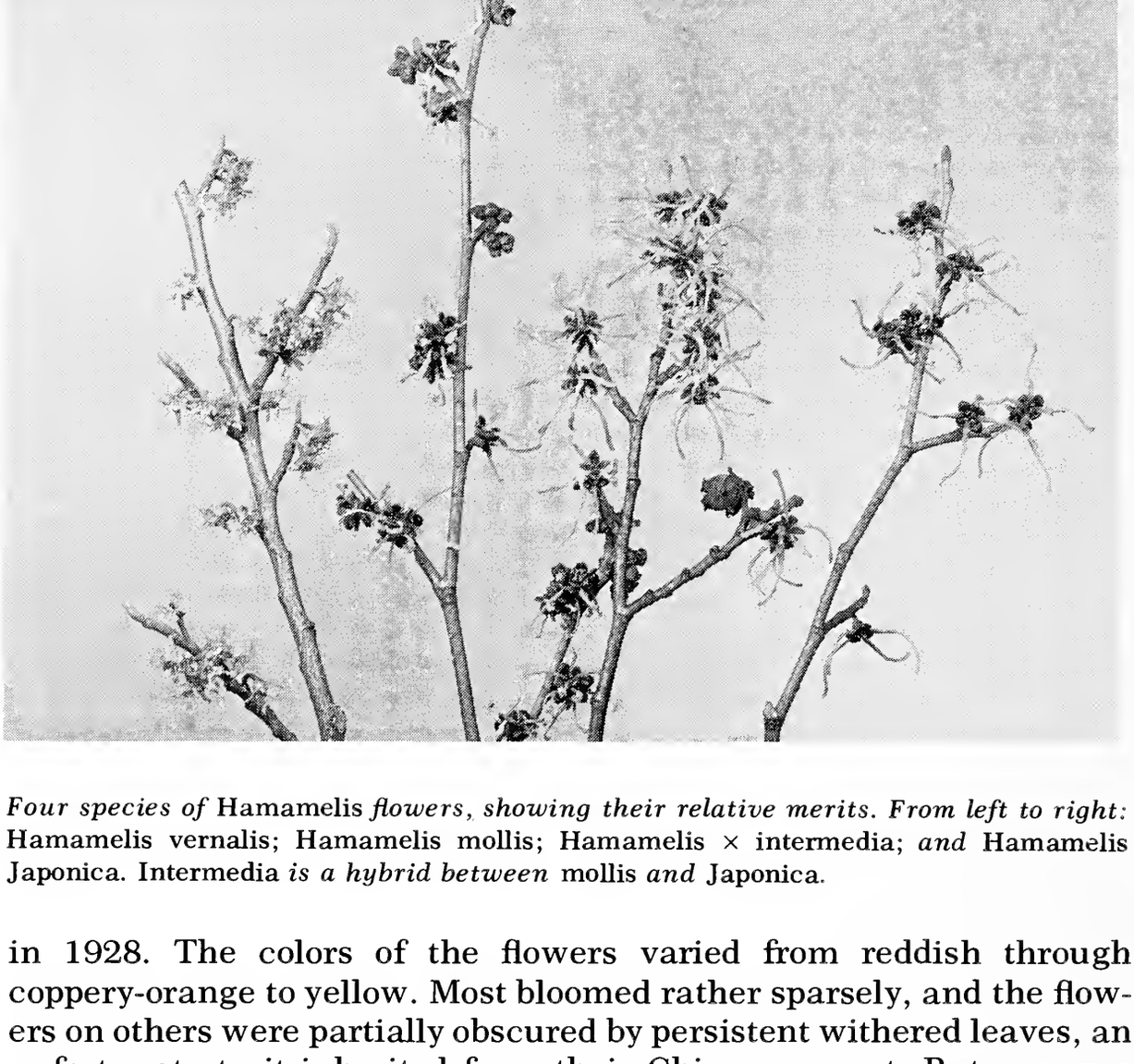
Hamamelis 'Arnold Promise'

In botanic gardens and arboreta, plants of closely related species are often grown in close proximity for display, educational, or research purposes. Hybridization between species results much more commonly in such situations than in the wild where the habitats of the same species may be separated by hundreds or even thousands of miles. Over the years many interesting and valuable ornamental plants have arisen in gardens through the unknowing intermediacy of the honey bee, making its daily rounds. *Forsythia x intermedia,* for instance, a hybrid between *F. suspensa* and *F. viridissima* was first observed to be growing in the Göttingen Botanic Garden in Germany around 1885. Since then, the hybrid has been recreated many times, and has given rise to most of our common garden forsythias. In the same way, a number of plants have arisen at the Arnold Arboretum, included among them, one of the finest shrubs ever to originate on its grounds.

In 1928, William Judd, the propagator at the time, collected seeds from a plant of the Chinese witch hazel *(Hamamelis mollis).* Its parent plant, illustrious in itself, had been grown from seeds collected by E. H. Wilson in China in 1905. The resulting seedlings turned out to be not *H. mollis* but rather appeared to be hybrids. The pollen parent (analogous to the father plant) was eventually determined to have been a closely adjacent plant of *H. japonica,* the Japanese witch hazel. Alfred Rehder in 1944 named the hybrid *H. x intermedia,* because its character was intermediate between its parents. Seven plants grew from the original hybrid seeds collected by William Judd

Hamamelis × intermedia *growing on the southwest side of the Arboretum administration building* (*see* back cover). *This plant (A.A. 23167) was given the cultivar name 'Arnold Promise' in recognition of its outstanding characteristics.*



Four species of Hamamelis *flowers, showing their relative merits. From left to right:* Hamamelis vernalis; Hamamelis mollis; Hamamelis × intermedia; *and* Hamamelis Japonica. Intermedia *is a hybrid between* mollis *and* Japonica.

in 1928. The colors of the flowers varied from reddish through coppery-orange to yellow. Most bloomed rather sparsely, and the flowers on others were partially obscured by persistent withered leaves, an unfortunate trait inherited from their Chinese parent. But one was spectacularly different with its profuse, slightly fragrant, clear yellow flowers. Its merit was eventually recognized and it was given the clonal name 'Arnold Promise'.

In general, witch hazels are large shrubs and small trees with a scattered distribution in eastern North America and eastern Asia. Four species are usually recognized. Although they are rarely grown as ornamentals in this country, they are extremely valuable because of their unique blooming times. Our native common witch hazel (*Hamamelis virginiana*) blooms from early October through mid-December in good seasons. In some years the Ozark witch hazel (*H. vernalis*) overlaps slightly, but it normally commences to bloom in early January. The extremely fragrant blooms of the Chinese species follow closely near the end of January, and the Japanese species ends the season with its flowers in March. The bright but not spectacular, fragrant flowers of witch hazel would perhaps not be much appreciated if they appeared during the riot of May, but they are a treasure in the drab winter. Its four strap-shaped petals appear very delicate but they are unharmed by sub-freezing temperatures. They merely coil up like a spring on unusually cold days and recoil with more temperate weather.

Hamamelis 'Arnold Promise' is the very best of the early-blooming

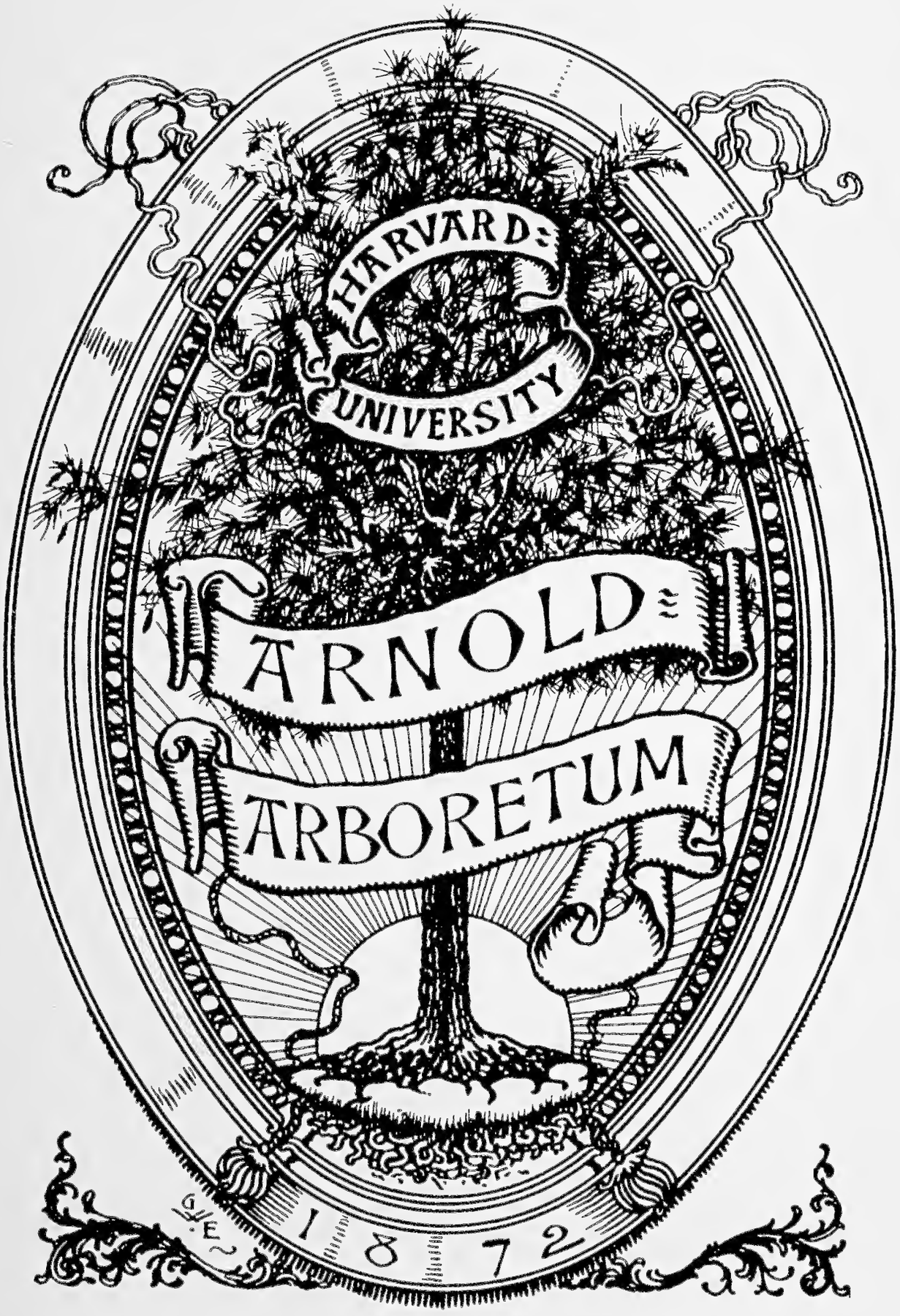
witch hazels, at least for New England gardeners. It is a far better plant than either of its parents, particularly in regard to its flowering. The flowers of *H. mollis* are individually more attractive and they are extremely fragrant. But they are seldom profusely borne in our climate and they are often damaged by severe cold. The flowers of *H. japonica* are larger, but they are rather dull-colored. The flowers of 'Arnold Promise' are unusual among witch hazels in that the spidery petal spread more or less downward rather than outward. They are consistently borne in great profusion, even after the coldest of recent winters, appearing from mid-February to early March depending on the season. The habit of the plant is also better than that of most witch hazels. The original plant, now 52 years old is a shapely, broadly vase-shaped shrub with numerous, gently ascending stems. It is presently about twenty feet tall and almost as broad. The autumn foliage is the color typical of many of its genus — clear, bright yellow — and the withered leaves never persist into the winter (see *Arnoldia* 39: 69–106).

The ornamental merit of 'Arnold Promise' has only recently been recognized, and it is just beginning to be available in the nursery trade.* The original plant is still tucked away in a corner of the Administration Building out of view from the passing public. However, its modest position, close at hand, keeps it always in mind of the staff of the Arboretum. They see in it, as Donald Wyman put it so well "an old friend, known for its performance, counted on because it has been there a long time, and not considered unusual for these reasons." But the 'Arnold Promise' is special. Its promise is the promise of spring.

Richard E. Weaver, Jr.

* The author will gladly supply nursery sources upon request.

Opposite: *The Arnold Arboretum insignia, based on a bookplate designed for Charles Sprague Sargent by George Wharton Edwards in 1892. The revised design carries the date 1872, the year the Arnold Arboretum was founded. The insignia is still used as a bookplate. It also is used for the Arnold Arboretum Award, given annually at the Massachusetts Horticultural Society Spring Flower Show for "excellence in the use of rare and unusual north temperate woody plants, in a complimentary landscape setting."*


HARVARD
UNIVERSITY
ARNOLD
ARBORETUM
1872

Inside back cover: Plantings of magnolia, daffodills, flowering cherries, and rhododendron provide an opulent setting for the Administration Building in Spring

In the Next Issue:

A Special Number on Magnolia

Magnolia Virginiana in Massachusetts

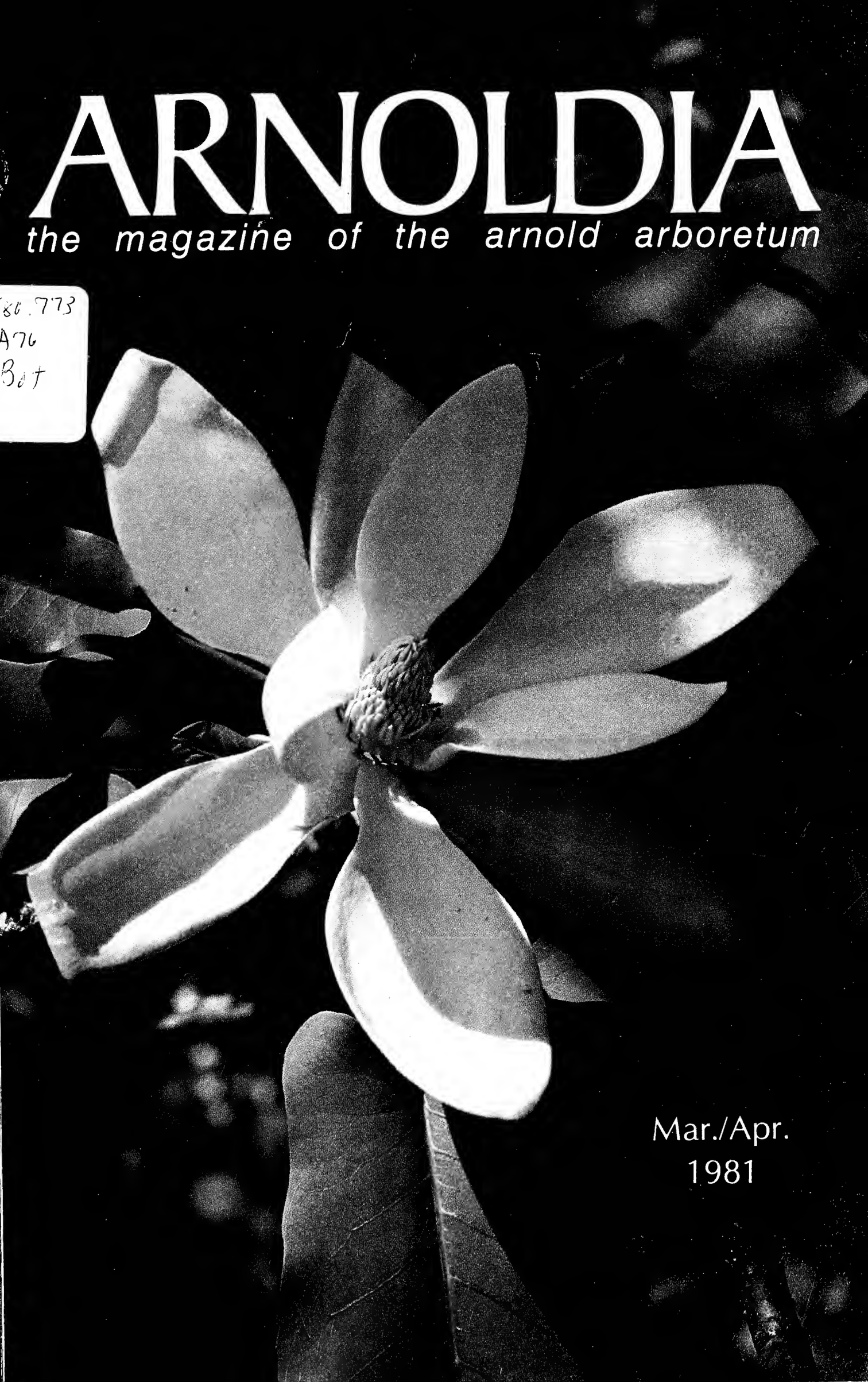
Magnolia Salicifolia
An Arboretum Introduction

Magnolia Fraseri

'Silver Parasol'
A New Magnolia Cultivar

ARNOLDIA

the magazine of the arnold arboretum



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1981

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Contents

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On the cover: A blossom of Magnolia fraseri *from a mature specimen, 10 m. tall, growing on the Sargent Trust, Brookline, Mass. Photograph by G. Koller.*

Magnolia virginiana in Massachusetts

by Peter Del Tredici

History

The sweet bay magnolia swamp in Gloucester, Massachusetts has been a botanical shrine since its discovery in 1806. Early New England naturalists and botanists of all types, from Henry David Thoreau to Asa Gray, made pilgrimages to the site of this northernmost colony of *Magnolia virginiana* L.* (fig. 1). The local residents of Gloucester were so impressed with a "southern" plant growing this far north that they changed the name of the Kettle Cove section of the town to Magnolia in the mid-1800s. It is probably no coincidence that this name change occurred at the same time the area was starting up its tourist trade.

In addition to its isolation, the Gloucester *Magnolia* population was remarkable for having escaped notice until 1806 in an area that was settled in 1623. This fact has led at least one author to speculate that the colony was not wild but escaped from a cultivated plant (Anonymous, 1889). However, the overwhelming consensus of earlier botanists is that the population is, in fact, native. Whatever its origin, the swamp remains today the unique and mysterious place it has been for almost 200 years.

Very little has been written about the magnolia swamp in recent years. The latest, and best, article about it was written by Dr. George Kennedy, and appeared in 1916 in *Rhodora*, the journal of the New

* The next nearest population of *M. virginiana* is growing 150 miles to the south on the eastern shore of Long Island, New York (Little, 1971).

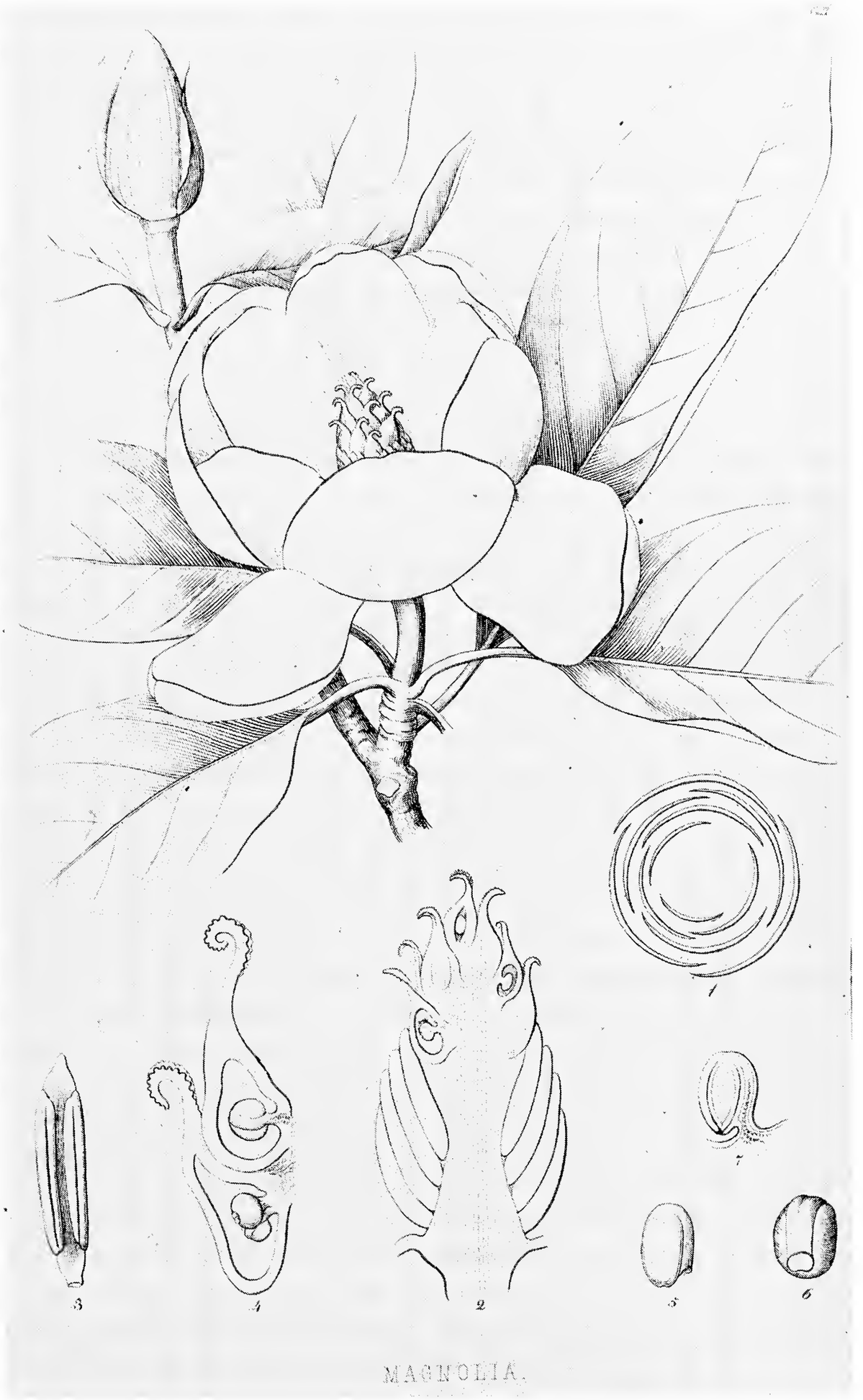

Figure 1. This drawing of Magnolia virginiana *appeared in 1849 in Asa Gray's* Genera Plantarum *(pl. 23), with the caption: ". . . a branch in flower of the Northern variety, from Gloucester, Massachusetts; of the natural size."*

England Botanical Club. Dr. Kennedy summarized the history of the stand, and cleared up the confusion about who discovered it by publishing a letter he found, written by the Honorable Theophilus Parsons to the Reverend Manassah Cutler in 1806. The letter captures the emotion of the moment of discovery:

> Reverend and Dear Sir:
>
> In riding through the woods in Gloucester, that are between Kettle Cove and Fresh Water Cove I discovered a flower to me quite new and unexpected in our forests. This was last Tuesday week [July 22, 1806]. A shower approaching prevented my leaving the carriage for examination, but on my return, on Friday last, I collected several of the flowers, in different stages, with the branches and leaves, and on inspection it is unquestionably the Magnolia glauca. Mr. Epes Sargent has traversed these woods for flowers and not having discovered it, supposes it could not have been there many years. It was unknown to the people of Gloucester and Manchester until I showed it to them. I think you have traversed the same woods herborizing. Did you discover it? If not, how long has it been there? It grows in a swamp on the western or left side of the road as you go from Manchester to Gloucester, and before you come to a large hill over which the road formerly passed. It is so near the road as to be visible even to the careless eye of the traveler. Supposing the knowledge of this flower, growing so far north, might gratify you, I have made this hasty communication.
>
> Your humble servant,
> Theoph. Parsons

The existence of the magnolia swamp was first announced to the general public in 1814 by Jacob Bigelow in the first edition of his famous *Plants of Boston*:

> The only species of this superb genus, that has been found native in our climate. It attains the height of a dozen feet, but is sometimes killed down to the roots by severe winters . . . The bark is highly aromatic, and possesses medicinal properties. It grows plentifully in a sheltered swamp at Gloucester, Cape Ann, twenty five miles from Boston, which is perhaps its most northern boundary. — June, July.

And on September 22, 1858, Henry David Thoreau visited the swamp and wrote about it in his *Journal*:

> Sept 22. A clear cold day, wind northwest.
> Leave Salem for the Cape on foot . . . We now kept the road to Gloucester, leaving the shore a mile or more to the right,

Figure 2. An unusually old, tall, multi-stemmed specimen of Magnolia virginiana *growing in the old C. S. Sargent estate in Brookline, Massachusetts. The tree is 10 meters tall. Photograph by P. Del Tredici.*

> wishing to see the magnolia swamp. This was perhaps about a mile and a half beyond Kettle Cove. After passing over a sort of height of land in the woods, we took a path to the left, which within a few rods became a corduroy road in the swamp. Within three or four rods on the west side of this, and perhaps ten or fifteen from the highroad, was the magnolia. It was two to seven or eight feet high, but distinguished by its large and still fresh green leaves, which had not begun to fall. I saw last year's shoots which had died down several feet, and probably this will be the fate of most which has grown this year. The swamp was an ordinary one, not so wet but we got about very well. The bushes of this swamp were not generally more than six feet high. There was another locality the other side of the road.

Clouds of doubt concerning the survival of the swamp started to gather in 1875, in *A Report on the Trees and Shrubs Growing Naturally in the Forests of Massachusetts* by George B. Emerson. He noted "scores" of trees broken down in a single season by people who sold the flowers in Boston and Salem. By 1889, the situation had deteriorated to the point that J. G. Jack, the dendrologist at the Arnold Arboretum wrote:

> So eagerly have the flowers been sought for by collectors, and especially by those who wished to make money out of the sale of both plants and flowers, that there has been some apprehension that the day would soon come when the Magnolia could only be classed in New England floras as one of the indigenous plants of the past.

But some good news also appeared in this article, for he goes on to say, "The hope is now entertained, however, that the owners of the woods where it occurs, appreciating its rarity and interest, will take care that its existence, in a wild state, may be perpetuated." And indeed it was, for in that same year, 1889, Mr. Samuel E. Sawyer, the owner of the swamp, set up a trust fund, to be administered by a board of trustees, to manage the land. He chose to call it "Ravenswood Park" and instructed that it be left open for and made accessible to the general public.

This great display of generosity, however, did not stem the tide of destruction. Dr. Kennedy in his *Rhodora* article quotes a letter from C. E. Faxon, the illustrator at the Arnold Arboretum, to a Mr. Walter Deane, which shows the condition of the swamp in the summer of 1913:

> April 17, 1916.
>
> Dear Mr. Deane:
>
> I have just found in Garden and Forest an interesting letter from Mr. Fuller giving a marginal note from Judge

> Davis's copy of Bigelow's Plants of Boston . . . When I first visited the swamp some 45 years ago there were plenty of good specimens all about, sometimes 15 feet tall or more. It was easy to find them, as the boys who sold the flowers on the Boston trains had made trails from one plant to another all over the swamp.
>
> When I visited the place with Dr. Kennedy two years ago we found with the aid of the Tree Warden of the town, only two little plants a few feet high that had escaped the Magnolia hunters — such had been the destruction!
>
> Yours faithfully,
> C. E. Faxon

More recently the story has developed a more cheerful turn. When I visited the swamp during the winter of 1981, I estimated there to be somewhere between 40 and 50 multi-stemmed clumps of *Magnolia virginiana.* Most of the stems were 2 to 4 meters tall, but there was one 6 meters high. Stem diameters ranged from 2 to 10 centimeters in thickness. About 1970, the trustees of Ravenswood Park thinned out some of the larger trees that were shading the magnolias that grew in the back part of the swamp. The effect of this selective thinning has been a great increase in the vigor and fruitfulness of the plants — so much so that in the fall of 1980, I managed to collect 938 fertile seeds from about half a dozen plants. By no means was this the total seed production of the colony, only what I could collect without doing damage to the trees.

In Jack's 1889 article, he listed the common plants of the swamp, and it is clear that it contained a great degree of diversity. When I visited the swamp in 1981, I had Jack's list with me so I was able to make some comparisons. As for the trees, not much has changed: hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*) and red maple (*Acer rubrum*) still dominate the canopy. In the shrub layer, however, there are fewer kinds of plants now than there were in 1889. Presently, blueberries (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), catbrier (*Smilax rotundifolia*) and tall *Osmunda* ferns are most abundant. Interestingly, the shade-tolerant evergreen inkberry (*Ilex glabra*), common in the swamp today, was not mentioned by Jack. Conversely, Jack reported that the sun-loving cranberry (*Vaccinium macrocarpum*) grew thickly in the swamp in 1889 but I couldn't find it anywhere. This absence of cranberry along with the decrease in the diversity of shrubs suggests that in 1889 the swamp was not as grown up with trees as it is presently. It also suggests that a periodic thinning of the canopy is the best way to maintain the swamp in a healthy condition.

In the spring of 1982, the Arnold Arboretum, in conjunction with the trustees of Ravenswood Park, plans to replant part of the swamp with seedlings grown from seed collected at the park in 1980. We will

Figure 3. An evergreen form of Magnolia virginiana *growing in the front yard of a private home in Milton, Massachusetts. The tree is 9 meters tall. The photograph was taken in February. Photograph by P. Del Tredici.*

Figure 4. The Milton magnolia, photographed from below, showing the thin, but evergreen, canopy. The photograph was taken in February. Photograph by P. Del Tredici.

concentrate our efforts on those parts of the swamp where the magnolia is not now growing but probably was originally. Our hope is that some day the swamp will contain as much magnolia as it did when it was discovered. Preparatory to the planting, the Board of Trustees plan to do some thinning of the now dense canopy to allow more light to reach the seedlings, thereby increasing the chances of their survival.

Other forms of *Magnolia virginiana*

In 1919, C. S. Sargent suggested that there may be two botanical varieties of *Magnolia virginiana,* a southern one, var. *australis,* and a northern one, var. *virginiana.* The southern form is evergreen, larger and more pubescent than the northern form. Subsequent authors have either contested or supported the validity of such a separation and to those articles the interested reader is referred (Ashe, 1931; McDaniel, 1966 and 1967; Spongberg, 1976). Suffice it to say that the situation is very complex and confused and that many different forms of *Magnolia virginiana* of uncertain origin can be found.

In the vicinity of the Arnold Arboretum, for example, there are two very striking, and very different specimens. The first one is 10 meters tall, multi-stemmed, deciduous and very vigorous. It is growing on the old C. S. Sargent estate, Holm Lea, in Brookline, Massachusetts (fig.

2), and is probably part of Sargent's original planting. The second specimen is a smaller, younger tree, with a single stem, growing in the front yard of a private home in Milton, Massachusetts. The remarkable feature of this plant is its strongly upright habit and its evergreen foliage held through the most severe winters (fig. 3, 4.) I have not yet determined whether this plant corresponds to McDaniel's definition of variety *australis*, but I plan to do so during the summer when blooms are produced. Regardless of its botanical name, it is a fascinating tree, that suggests that a reliably evergreen magnolia for Massachusetts may not be just a fantasy. Unfortunately, nothing is known about the tree's history except that it was planted by the Blue View Nurseries of Canton, Massachusetts in the 1950s.

The existence of these two different forms of *Magnolia virginiana*, along with the smaller native form, suggests that the enterprising plant breeder has good material to work with when selecting for a hardy, evergreen magnolia. It is also possible that by crossing the Gloucester form with some of the hardiest clones of *Magnolia grandiflora*, that evergreen hybrids hardier than *Magnolia* 'Freeman' may be possible (McDaniel, 1966).

Seed Germination

On October 13, 1980, 938 sound seeds were collected from various plants of *Magnolia virginiana* growing at Ravenswood Park. On this day, the fruit aggregates were just beginning to crack open, revealing the bright scarlet seeds inside (see back cover). In processing the seeds, the first step was to clean them. This was done by allowing them to soften up in a plastic bag for a week, and then washing them in running water. Once the seeds were clean, I noticed that the hard bony layer on all of them was a creamy white (fig. 5). This is curious since all illustrations I could find show this layer to be black (Sargent, 1890; Schopmeyer, 1974; Wood, 1974). However, Professor J. C. McDaniel of the University of Illinois has told me that he has seen plants with white or mottled bony layers.

Once the fleshy layer was removed, the seeds were air dried overnight and placed in a moist stratification medium consisting of half peat moss and half sand. They were then put in a refrigerator kept at 2°C. Every two weeks, one hundred seeds were removed and sown in medium grade vermiculite and placed in a greenhouse kept at constant 18°C with supplementary light from 4 p.m. to midnight. The purpose of the experiment was to see exactly what the minimum chilling requirement of *M. virginiana* was, given that the standard recommended treatment is a rather broad recommendation of three to six months (Schopmeyer, 1974). The results of the experiment can be seen in Table 1. It should be noted that while unchilled seeds did give 12% germination, they did so only very slowly and irregularly in comparison to the chilled seeds.

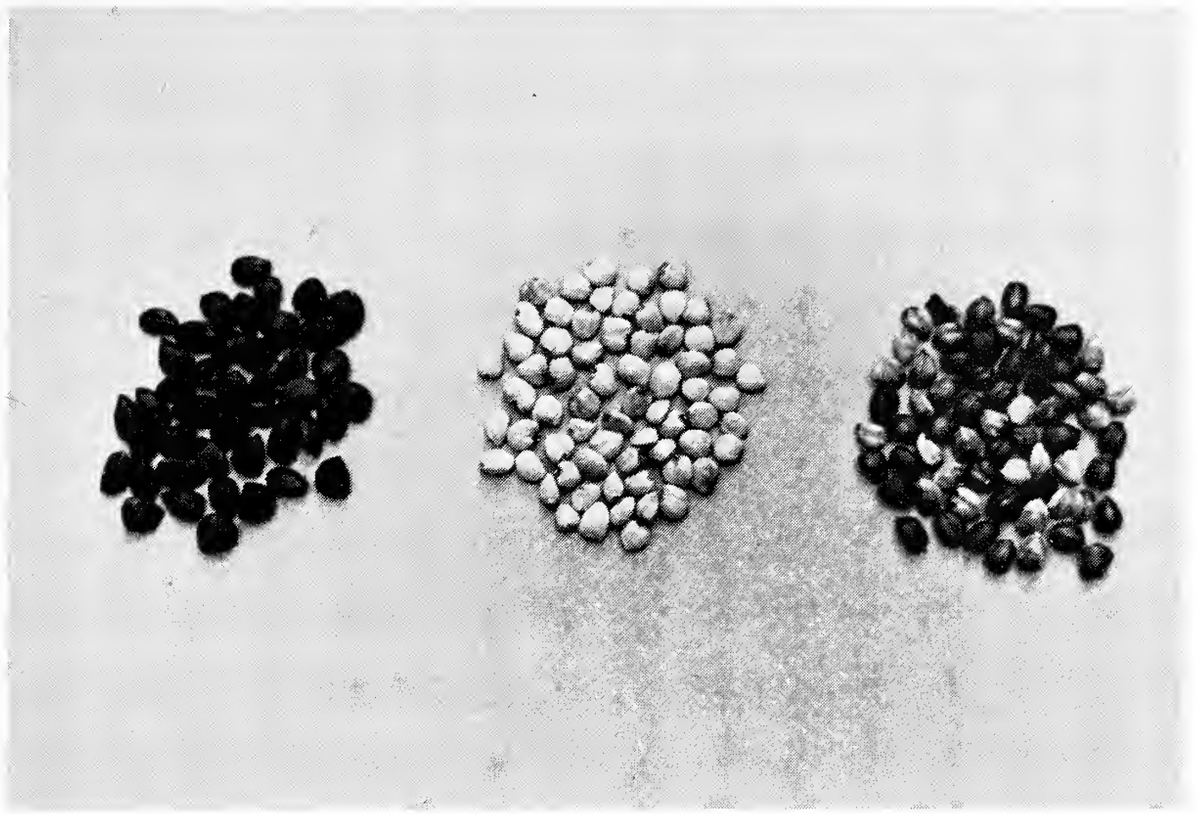

Figure 5. Cleaned seeds of Magnolia virginiana. *The black seeds on the left are from the tree at the C. S. Sargent estate (figure 2). The white seeds in the middle are from the Gloucester population, and the mottled seeds on the right are from the evergreen Milton tree (figure 3). Photograph by P. Del Tredici.*

Table 1. Germination behavior of cleaned seeds of *Magnolia virginiana.*

Cold Stratification Period (in Days)	Sow Date	Number of Days to Germination*	% Germination as of 10 Feb. 1981
0	21 Oct 80	60	12%
14	4 Nov 80	57	14%
27	17 Nov 80	42	80%
42	2 Dec 80	34	84%
58	18 Dec 80	33	93%

* Germination is defined as the emergence of the hypocotyl above the soil surface.

When the seeds of *M. virginiana* are shed (and indeed, in all magnolias that I have observed or read about), the embryo is minute, being less than 20% of the length of the seed itself. When the seeds are taken from stratification, regardless of whether it is for one month or four months, the embryo shows little or no change in size. However, immediately upon sowing, the embryo starts to grow, so that after 14 days the embryo is about 50% as long as the seed and after 30 days, the cotyledons are almost as long as the seed and the radicle has broken through the seed coat. After 40 days, the germination is usu-

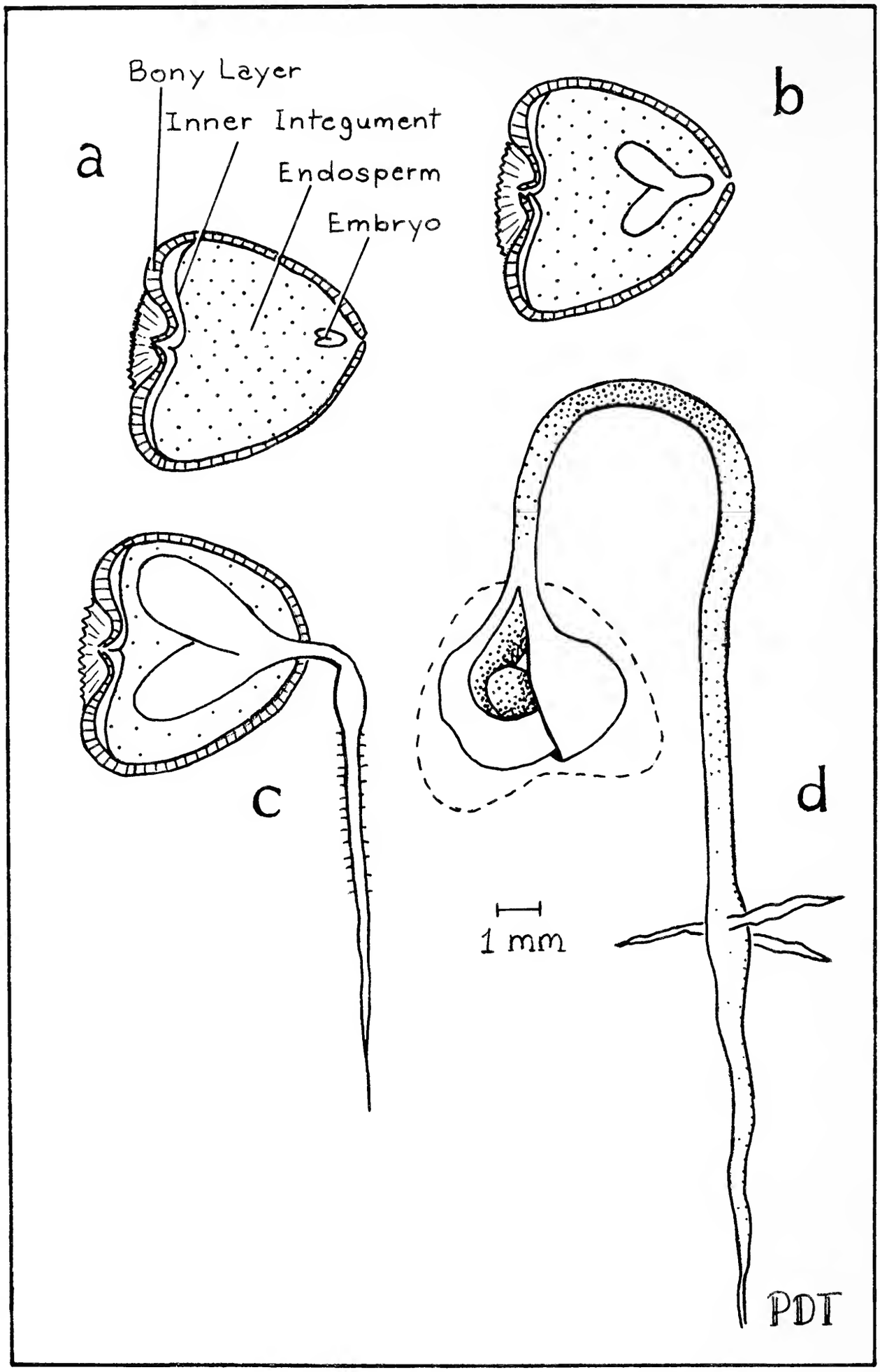

Figure 6. Seed germination sequence of Magnolia virginiana *after 90 days of cold stratification: (a) the day the seeds were sown; (b) 14 days after sowing; (c) 32 days after sowing; (d) 40 days after sowing, germination nearly complete.*

ally complete (Fig. 6). In contrast, the unchilled seed showed no uniformity. After 112 days, some embryos were still at the same developmental stage as they were when they were shed from the plant while others were fully germinated.

A germination process similar to that of *Magnolia virginiana,* where there is a chilling requirement in order to allow the embryo to complete its development, has been reported for *M. grandiflora* (Evans, 1933), and *M. acuminata* (Afanasiev, 1937), and my own observations have shown that it holds true for *M. tripetala* and *M. macrophylla* as well. It is also true for another member of the Magnoliaceae, the tulip tree (*Liriodendron tulipifera*) (Wean and Guard, 1940). In effect, what is happening is that the underdeveloped embryo requires a chilling period in order to remove the block that keeps it from developing. However, the embryo will not grow until it is moved to a warm environment. Thus, *Magnolia* seeds require a cold period (of about two months) followed by a warm period (of about one month) before they will germinate. What looks like an ordinary chilling requirement is, in reality, a special type of double dormancy. As far as I can tell, this dormancy type has never been recognized by seed dormancy specialists (Crocker and Barton, 1953; Stokes, 1965; Villiers, 1972; Mayer and Poljakoff-Mayber, 1975).

The situation in *Magnolia* contrasts with other dicotyledons that shed ripe seeds with underdeveloped embryos. In the case of *Panax ginseng* (Grushvitskij, 1956), and *Ilex opaca* (Ives, 1923), the tiny embryo grows to full size in warm temperatures but then will not germinate unless it receives a chilling period of 2 to 3 months. A variation of this type of dormancy is shown by *Viburnum acerifolium* (Giersbach, 1937) in which the radicle germinates during the warm period, but the epicotyl requires a chilling in order to grow. In the case of *Viburnum nudum*, on the other hand, both the radicle and the epicotyl grow to maturity and germinate without requiring any chilling. Finally, in the case of the herbaceous cow parsnip, *Heracleum sphondylium* (Stokes, 1952), the underdeveloped embryo actually grows to full size during the chilling process and will even germinate in the refrigerator, something *Magnolia* never does.

Thus, within the category of dicots which shed their seeds with underdeveloped embryos (which I shall arbitrarily define as having embryos less than 25% of the length of the mature seed), we have four basic germination behaviors: (1) plants which require only warm conditions; (2) plants which require a warm period and then a cold period; (3) plants which require only a cold period; and (4) plants which require a cold period followed by a warm period.

It should be kept in mind, of course, that the lack of a precise definition of germination complicates this otherwise neat situation. Villiers (1972) sums up the basic problem that one faces in discussing seeds with immature embryos, by noting that: "It is difficult to decide whether this embryo development is part of the final stage of seed development or the initial stage of the germination process." In spite

of this intrinsic difficulty, the type of dormancy shown by *Magnolia* and *Liriodendron* is distinct enough from those types already recognized to merit a classification of its own.

Acknowledgments

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Magnolia salicifolia An Arboretum Introduction

by Stephen A. Spongberg

Through the years, the Arnold Arboretum has introduced several species of *Magnolia* into western gardens from eastern Asia, the region in which the genus attains its greatest diversity. The majority of these introductions, however, has not proved hardy in the Boston area, and relatively few Asiatic species of *Magnolia* are included in the arboretum's living collections. We are particularly unfortunate that the several spectacularly ornamental species of section *Yulania* (including *M. dawsoniana* Rehder & Wilson, *M. sargentiana* Rehder & Wilson, and *M. sprengeri* Pampanini) have not withstood the New England climate. The likelihood that these and several other Asiatic species collected by E. H. Wilson would probably not prove hardy in Boston prompted C. S. Sargent, the arboretum's first director, to ship Wilson's collection of magnolias obtained in China to Leon Chenault in Orleans in the south of France with the request that they be propagated and distributed as widely as possible. Sargent's correspondence with Chenault (Sargent, 1913) states that of Wilson's Chinese magnolia collections at the arboretum, only one or two individuals of each remained, and that these involved too much labor since they were in pots that had to be placed in a pit for protection each winter.

Far greater success, however, has been achieved in the culture of

Illustration of Magnolia salicifolia *from* Curtis' Botanical Magazine (*139 (1913): t. 8483*).

Asiatic species of section *Buergeria* at the Arnold Arboretum, and all of the species thus far tested have proved hardy in the Boston climate. The first plants of this Asiatic group to be received at the arboretum directly from Asia were raised from seed collected on the northern Japanese island of Hokkaido. These seeds were sent to Sargent in 1876 (four years after the establishment of the arboretum) by Professor William Smith Clark, a New Englander from the University of Massachusetts who was in Japan helping to establish the Hokkaido Agricultural College in Sapporo. Plants from Clark's seed were subsequently designated as *Magnolia kobus* Maxim. var. *borealis* (now included within var. *kobus*), which Sargent distinguished from typical *M. kobus* due to it northern origin and supposed more treelike habit. The original plant raised from Clark's seed was planted at Sargent's estate, Holm Lea, in Brookline, and plants for the arboretum were subsequently obtained from that tree.

The first magnolia to be introduced directly by the Arnold Arboretum was collected by Sargent himself during his first trip to Japan in 1892. Together with his nephew, Philip Codman, and James Herbert Veitch, who Sargent and Codman had met on Hokkaido, Sargent made an ascent of Mt. Hakkoda on northern Honshu (the main Japanese Island) in early October of that year. While the trek to the summit of the mountian was specifically to see and collect seed of the then little known fir, *Abies mariesii* Mast., the dominant forest tree at the summit, Sargent and Veitch returned with seed collections of *Magnolia salicifolia* (Sieb. & Zucc.) Maxim. collected on the lower slopes of the mountain.

Both Sargent and Veitch published accounts of their travels, and Veitch included in *A Traveler's Notes* a brief account of their ascent of Mt. Hakkoda. He wrote that "Within a few hundred feet of the top of the mountain we came to a collection of low straw huts in which we passed two nights. They were too low to stand in, and as they were without window or chimney, we were only glad to remain at full length to avoid the fumes of the smoke of the large fire rendered necessary by the intense cold. Immediately above these huts lies the forest of *Abies Mariesii*, a most handsome and striking fir. . . . " (Veitch, 1896, p. 130).

Veitch failed to mention *Magnolia salicifolia*, probably because he was too impressed with the Japanese white bark magnolia, *M. hypoleuca* Sieb. & Zucc., which the climbers encountered as a large forest tree on the lower slopes of Mt. Hakkoda. Sargent (1894), by contrast, gave no personal recollections of the climb in his *Forest Flora of Japan* but limited his observations to the plants seen and collected on his Japanese trip. He also included an illustration [Plate 4] of a branchlet of *M. salicifolia* with a mature fruit aggregate that was drawn from the dried specimens he had collected on Mt. Hakkoda. He wrote (Sargent, 1894, pp. 10, 11) that "On Mount Hakkoda *Magnolia salicifolia* is a common plant between 2,000 and 3,000 feet above sea-level. As it appears there it is a slender tree fifteen or twenty

E. FAXON del.

MAGNOLIA SALICIFOLIA, MAXM.

Illustration of Magnolia salicifolia (*pl. 4*) *from Charles Sprague Sargent's* Forest Flora of Japan *published by Houghton Mifflin and Co., Boston, in 1894.*

feet high . . . *Magnolia salicifolia* is new to cultivation, and we were fortunate in obtaining a good supply of seeds, by means of which it is to be hoped, this interesting tree will soon appear in gardens."

Veitch's share of the seeds of *Magnolia salicifolia,* which were handled by the Veitch family's famous Royal Exotic Nursery in Chelsea, England, failed to grow, but those brought back to the Arnold Arboretum by Sargent and Codman were successfully germinated. Sargent and Codman returned not only with the Mt. Hakkoda seed but also with seed from an isolated plant of *M. salicifolia* that was located a month later when they were collecting 200 miles further south in the hills below Mt. Ontake. The species is now known to have a wide distribution in Japan (Kurata, 1971, distribution map, p. 175), occurring on Honshu, Shikoku, and Kyushu, where it grows at moderate elevations in beech and oak forests primarily in the Sea of Japan drainage.

It appears that germination must have been sufficient for Sargent

to share either seedlings or young plants with the Veitch firm, since the species was listed in their 1902 catalogue (Bean, 1973, p. 125). Treseder (1978, p. 125), however, states that *Magnolia salicifolia* was probably not introduced into European gardens until 1906 when a plant was sent to the Royal Botanic Gardens, Kew, by the Yokohama Nursery Company of Japan. Moreover, it is not evident from the arboretum's records if plants were grown at the Arnold Arboretum from both the Hakkoda and Ontake collections or only from the former. It is also not known if Sargent distributed his seedlings widely in North America; unfortunately, none of the plants of *M. salicifolia* growing in our living collections today can be traced back directly to Sargent's introduction.

When Sargent introduced *Magnolia salicifolia* into cultivation, its flowers were apparently unknown to botanists. The species had been described as early as 1846 by Siebold and Zuccarini, who placed it in the genus *Buergeria,* but in 1872 it was transferred to *Magnolia* by the Russian botanist, Maximowicz. Considering the fact that each spring the plants are covered with a profusion of flowers that almost obscure the slender, twiggy branches, it is difficult to think that the flowers of such a profusely floriferous species were unknown until after its introduction into cultivation.

Like other species of sect. *Buergeria,* the flowers of *Magnolia salicifolia* appear before the plants have come into leaf, and the plants are usually covered by the white flowers (even at an early age) that emerge from the silvery- or yellowish-hairy terminal buds. These buds differ from the smaller, yellowish or blackish vegetative buds that are finely silky hairy or occasionally glabrous, and flowering occurs during the first warm days of spring, usually toward the end of April at the Arnold Arboretum.

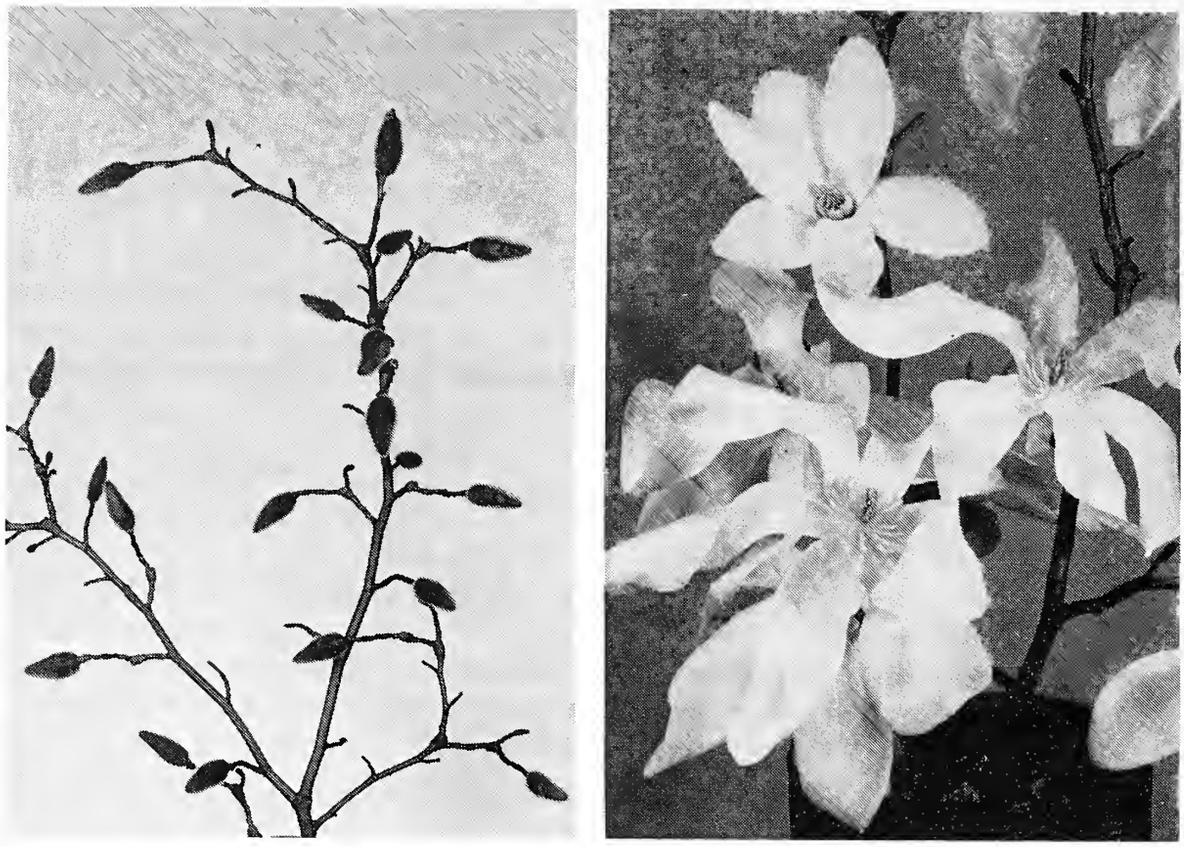
The flowers are often faintly fragrant, are held more-or-less horizontally at the ends of the branchlets on glaborus or slightly hairy flower stalks, and are often subtended by a small, expanding leaf. The petal-like structures that give the flowers their beauty are botanically termed tepals and consist of two types. There is an outer whorl of three (rarely more) very small tepals (up to 3.5 cm. long by 1 cm. wide), and by comparison to the inner tepals, each looks like a small sepal. The two (rarely three) inner whorls consist of six (rarely to twelve) petal-like tepals that usually measure between 5 and 12 cm. in length and 2 and 4 cm. in width. Each of these petaloid tepals is broadly spatulate or straplike in outline and is snowy white except for the lower portion on the outer surface, which is sometimes greenish or flushed pink. The size (and probably the weight) of the individual tepals often cause them to droop, and the flowers to appear rather floppy and shapeless. If the center of the flower is examined numerous yellowish or whitish, often pinkish-tinged stamens will be seen immediately below the small, greenish, protruding gynoecium or female reproductive portion of the flower. As the flowers age, or if a late spring frost damages them, the tepals turn brownish and fall to the ground. If pollination

has been affected, the gynoecium, a spindle-like structure that consists of an aggregation of small carpels, remains on the brachlets and will gradually develop into a mature fruit aggregate as the growing season progresses. By late summer and fall it will have achieved a cylindrical shape and attain a length of up to 7.5 cm. Occasionally these aggregates of mature carpels, termed follicles, will be symmetrical, but usually (due to the unequal development of seeds in the individual follicles and the complete abortion of others) the aggregates become twisted or curved. Initially green, the aggregates become a dull pink or reddish as the individual follicles split open and the red seeds are exposed and pushed out and hang suspended from the follicle walls on thin threads.

Long before the fruit aggregates mature but shortly after the flowers have browned and as the tepals drop to the ground, the leaves from the terminal and lateral vegetative buds begin to expand and the plants come into leaf. The leaves of *Magnolia salicifolia* are generally needed for the correct identification of the species since the flowers are very difficult to distinguish from those of *Magnolia kobus,* another Japanese species of section *Buergeria.* Each leaf is borne on a yellowish leaf stalk 12–20 mm. long, and the blades are usually lanceolate or oblong-lanceolate in outline, widest at or below the middle, and with acute to almost rounded apices, irregularly wavy margins, and tapering to almost rounded bases. In general appearance the leaves are suggestive of those several species of willow, and this similarity has given rise to the use of the common name, willow-leaf magnolia. When the leaves are crushed, or if the branchlets are snapped or bruised, they emit a pleasing lemony or anise-like odor that has given rise to another common name, anise magnolia.

While the upper surfaces of the leaves are dull green and usually without any hairs, the pale green lower leaf surfaces are sometimes covered with a whitish bloom and are always very finely and inconspicuously hairy over the entire surface or at least adjacent to the yellowish-green midveins. A hand lens is often needed to detect these hairs. The combination of leaf shape and lower leaf surface pubescence is diagnostic for the species and allows for correct identification (Spongberg, 1976a, Christensen, 1980).

Plants of *Magnolia salicifolia* are quite variable in habit, and they appear to be very tolerant of a wide range of soils and exposures. Sargent (1894, p. 10) noted that on Mt. Hakkoda this magnolia "is a slender tree fifteen or twenty feet high, with stems three or four inches thick, covered with pale smooth bark, and sometimes solitary, or more commonly in clusters of three or four." Richard E. Weaver and I were fortunate to collect seeds of *Magnolia salicifolia* during our arboretum-sponsored collecting trip to Japan in 1977, and our seeds were collected from small multi-stemmed shrubs that grew to about eight feet in height in the densely shaded understory of the deciduous forest on the slopes of Mt. Kashi near Nikko. These plants were growing on relatively steep slopes and on the shoulder of the trail, and it is



The buds and flowers of Magnolia salicifolia. *Photographs from the Arnold Arboretum archives.*

probable that the plants were in well drained soils. Sargent observed that on Mt. Hakkoda the plants grow "in low wet situations, generally near streams," and he surmised that it is a moisture-loving plant. Kurata (1971, p. 18) writes that "This magnolia is not uncommon in the cool-temperate forests in Japan, especially on the Japan Sea side in Honshu, favoring rather dry sites along mountain-ridges." At the Arnold Arboretum we have been equally successful in growing *Magnolia salicifolia* on the margin of the Leitneria Swamp along Meadow Road, as well as in the better drained soils of the gentle slope below the Arborway wall. In both of these locations our plants have formed rather slender, pryamidal, somewhat fastigiate single-trunked trees with dull silvery or brownish-gray bark, although other plants known in cultivation are large, multi-stemmed shrubs or rounded-crowned trees.

The variability in plant habit as well as in the size, shape, and degree of glaucousness of the under surfaces of the leaves have been the basis on which several botanists and horticulturists have described variants of *Magnolia salicifolia* (see Millais, 1927; Johnstone, 1955; and Treseder, 1978). And, it is my opinion (Spongberg, 1976a) that this variability, coupled with variation in the number and size of the inner, petaloid-like tepals of the flowers (cf. Kurata, 1971, *pl. 9*), led to the mistaken recognition of seedlings of *M. salicifolia* that arose in cultivation as hybrids. In two of the three instances in which putative hybrids involving *M. salicifolia* were described, it was suspected that other species of section *Buergeria* were the pollen parents. Thus Rehder (1939) described a hybrid between the anise magnolia and *M.*

kobus var. *stellata* (Sieb. & Zucc.) Blackburn, the star magnolia (which is sometimes retained as a distinct species, *M. stellata*), giving the name *M.* × *proctoriana* to the hybrid group, while S.A. Pearce (1952) gave the collective name *M.* × *kewensis* to presumed hybrids between *M. salicifolia* and *M. kobus* var. *kobus*. The third hybrid recognized that presumably involved *M. salicifolia* as the seed parent and *M.* × *soulangiana* as the pollen parent was named *M.* × *slavinii* by Bernard Harkness in 1954. However, this putative trihybrid was later (Harkness, 1961) reduced to the synonomy of *M.* × *proctoriana* since its chromosome number, $2n = 38$, is the same as that of *M. salicifolia* and not what was to be expected if *M.* × *soulangiana*, $2n = 95, 114$, had been the pollen parent.

While it is well known that magnolias hybridize freely in cultivation (see Spongberg, 1976a & 1976b, and Treseder, 1978), and a new magnolia cultivar is described and named elsewhere in this issue of *Arnoldia* that is considered to be a putative hybrid, the detection of chance magnolia hybrids should be based on a careful analysis that includes a review of the variability of the suspected parental species in nature as well as in cultivation. While the putative hybrids involving *Magnolia salicifolia* mentioned above do not appear (based on the type specimens and/or plants) to be hybrids but only variants of *M. salicifolia* itself, more study is definitely needed to fully resolve this problem. The most direct approach to these problems would involve a controlled hybridization program that would include documentation of the morphological characteristics of both parents and the hybrid offspring, should any result.

As indicated above, two of the putative hybrids involving *Magnolia salicifolia* were suspected of involving other taxa of section *Buergeria*. All of the species of this Asiatic section are now thought to be in cultivation, and many fine ornamentals have been selected from this group and are available commercially. In addition to the willow-leaf magnolia, the species of section *Buegeria* include the well known *M. kobus* of Japan, which includes var. *stellata*, the star magnolia, and var. *loebneri* (Kache) Spongberg, an intraspecific hybrid that arose in cultivation between *M. kobus* var. *kobus* and *M. kobus* var. *stellata*. Another less well known but beautiful species of the section is *M. cylindrica* Wilson, which was introduced from China by the late Mrs. J. Norman Henry of Gladwyne, Pennsylvania, in 1936. Even less well known, but perhaps the closest relative of *M. salicifolia* is *M. biondii* Pampanini, also of China, which was originally introduced by E.H. Wilson for the Arnold Arboretum in 1908. Wilson's seeds, however, apparently failed to germinate, and it was not until Dr. Ting Yu-chen of Boston University traveled to China in 1977 that viable seed of *M. biondii* was re-introduced to the United States. A portion of Dr. Ting's seed was kindly given to the Arnold Arboretum, and we are now growing plants from which quantities of grafted plants of *M. biondii* will eventually be made available for distribution and testing both in the United States and abroad.

Like *Magnolia salicifolia* when it was introduced by Sargent in 1892, *M. biondii* is an imperfectly known species and we should caution that a true impression of that species will probably not be forthcoming fom Dr. Ting's introduction into western gardens. It should also be mentioned that two additional Chinese magnolias, *M. amoena* Cheng, and *M. zenii* Cheng, are other imperfectly known species that have tentatively been placed in section *Yulan*, but which may prove in the final analysis to be members of section *Buergeria*. The sectional placement of *M. zenii* may soon be resolved, since the American members of the 1980 Sino-American Botanical Expedition to Western Hubei Province were fortunate to be given seed of that species in October of 1980 when visiting in Nanking. A portion of these seeds are currently being processed at the arboretum's Dana Greenhouses, and it is gratifying to me that 88 years after the Arnold Arboretum introduced its first Asiatic magnolia another introduction has been received. A tradition established by Charles Sprague Sargent is being continued in the arboretum's second century, and it is heartening that this new magnolia introduction resulted from the cooperative efforts of five American botanical institutions and our Chinese colleagues.

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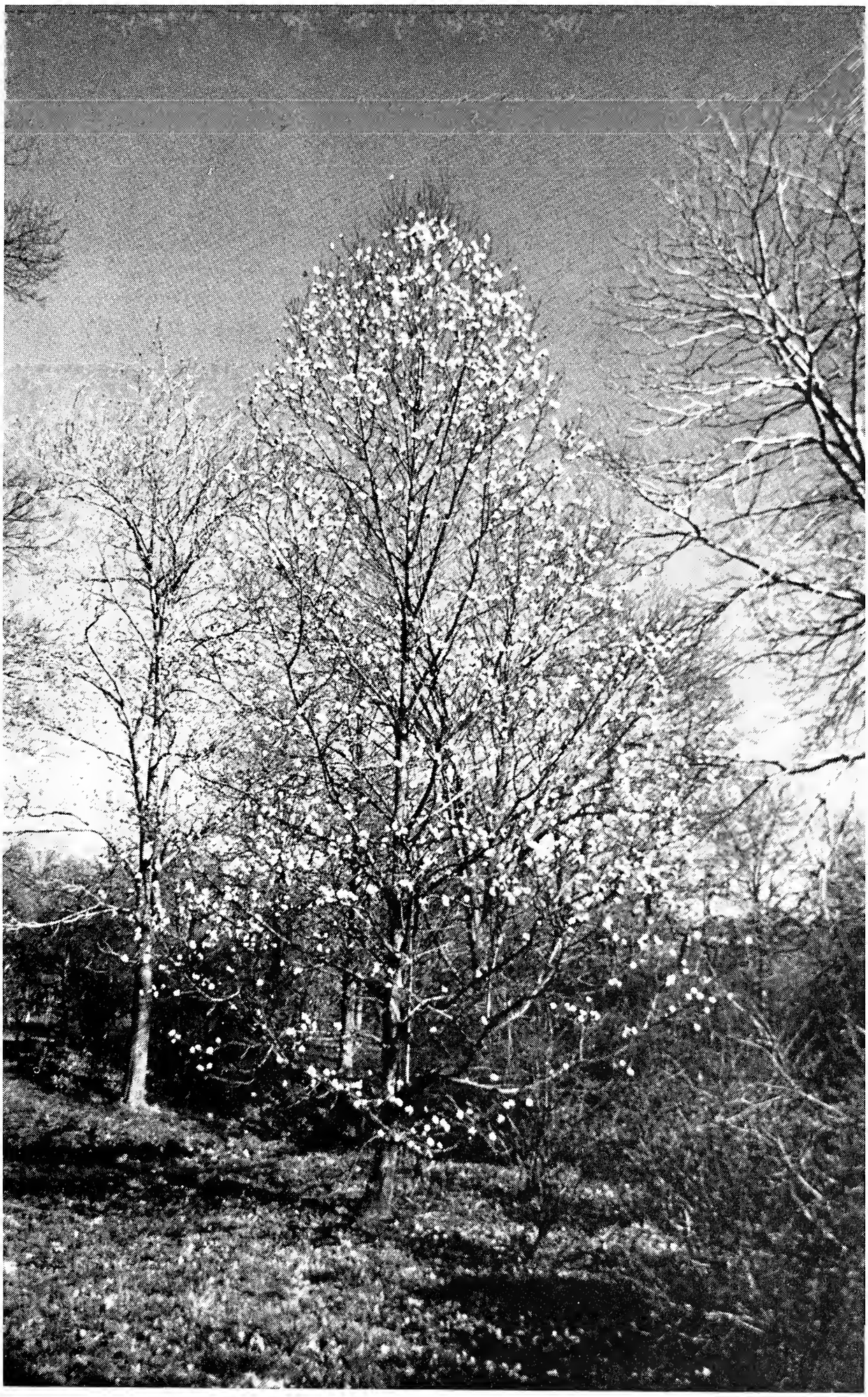


Magnolia salicifolia *in full-bloom at the Arnold Arboretum.* *Photograph by G. Koller.*

Magnolia fraseri

by Richard E. Weaver, Jr.

The umbrella magnolias (section *Rhytidospermum* of *Magnolia*), are comprised of 8–10 species, variously distributed in the southeastern United States (3–5 species, depending on the taxonomist), the mountains of Mexico (2 species) and eastern Asia from the Himalayas through China and Korea to Japan (3 species). The most conspicuous feature of this group are the large leaves clustered at the ends of the branches, simulating an umbrella and accounting for the common name. The species are not currently popular in American horticulture, perhaps because their bad habits are concentrated in *Magnolia tripetala,* the most commonly cultivated species and the one to which the name "umbrella magnolia" is often exclusively applied in common usage. With its gaunt habit and undistinguished, ill-scented flowers, this species certainly pales as an ornamental when compared with other magnolias such as *M. kobus* and its varieties and the numerous cultivars of *M.* × *soulangeana.* In addition, the characteristic large leaves of the group make the plants somewhat difficult to site effectively in a landscape situation. In the American *M. macrophylla,* for instance, they reach enormous proportions — as much as three feet long and a foot broad, the largest simple leaves of any native woody plant. On the other hand, these large leaves impart to the plants a decidedly unusual and exotic appearance, and several species have

attractive, fragant flowers followed by large and conspicuous, reddish fruit aggregates. A few species combine these favorable characteristics with a refined growth habit, making them first class garden plants worthy of more frequent cultivation. Among these is *Magnolia fraseri*, known as the mountain, eared, or Fraser's magnolia, one of our lesser known, native ornamental trees.

Magnolia fraseri was named for John Fraser, a Scot who made numerous trips to North America between 1783 and 1809 in search of plants which might prove to be useful ornamentals in the British Isles. During his second trip, in 1785, he met Thomas Walter near Charleston, South Carolina, who was at work on a compilation of the plants of the Carolinas. When he returned to England, Fraser took Walter's manuscript with him and had it published in 1788. Many plants were described for the first time in Walter's *Flora Caroliniana*, including *M. fraseri* which he named in honor of his benefactor.

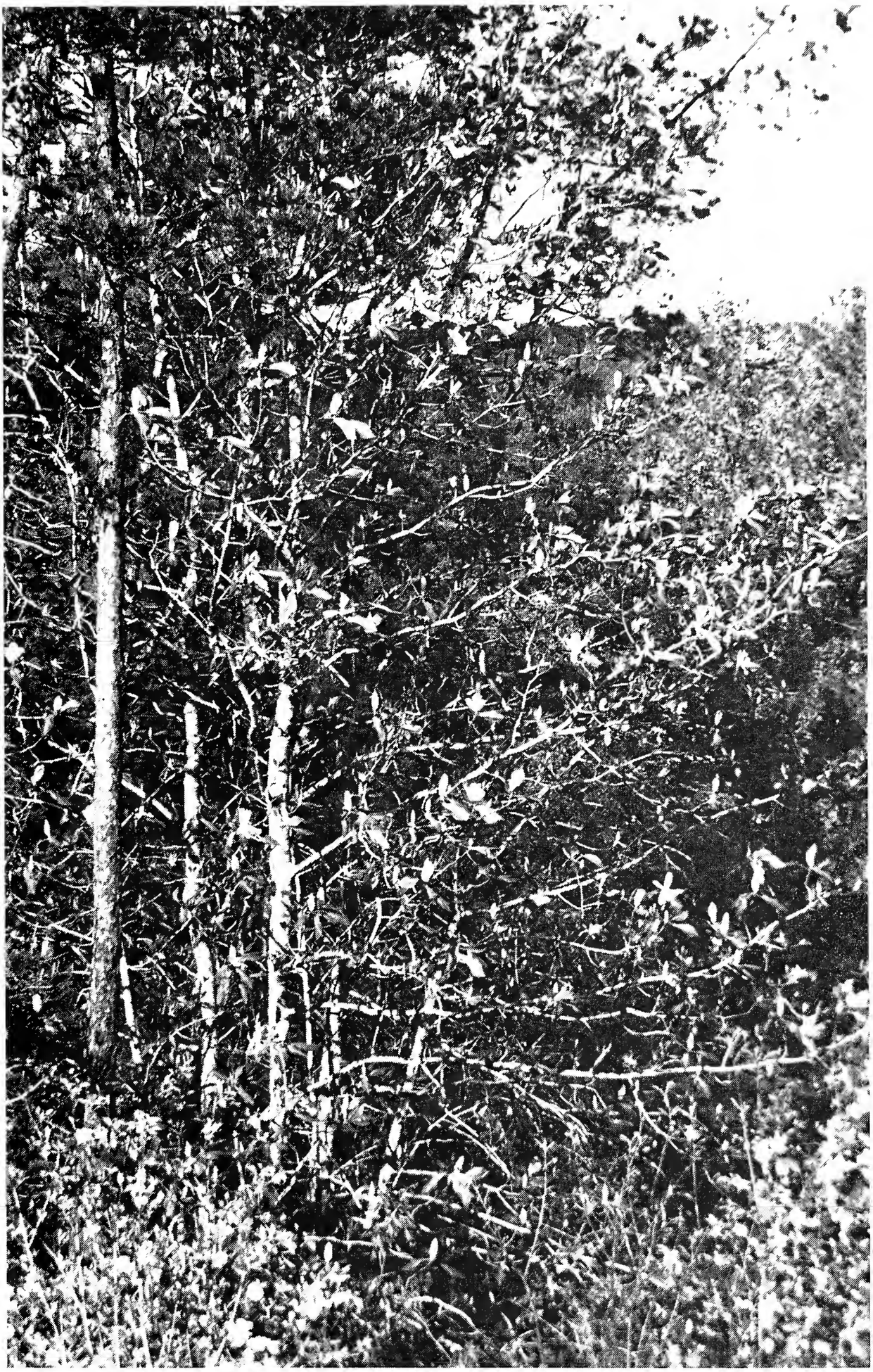
Fraser may also have been responsible, in 1786, for introducing *Magnolia fraseri* into cultivation in England, as reported by W. T. Aiton in the second edition (1811) of *Hortus Kewensis*, a catalogue of the plants cultivated at the Royal Botanic Garden, Kew. But, according to J. C. Loudon, this honor must be shared by William Bartram who reportedly also sent the plant to England in 1786. William Bartram was one of the most important as well as one of the most picturesque of early American naturalists and plant explorers. He was the son of the equally illustrious John Bartram, also a plant explorer but, in addition, the founder of a garden on the banks of the Schuylkill River near Philadelphia, which is generally recognized to be the first botanic garden in the United States. From 1773 until 1777 the younger Bartram travelled through the southeastern United States in search of unusual plants and animals for his patron, the insatiable English collector, Dr. John Fothergill. The account of his travels (*Travels through North and South Carolina, Georgia, East and West Florida*, originally published by James and Johnson in London in 1792 but reprinted in facsimile by Beehive Press, Savannah, Georgia in 1973) is one of the classics of American natural history. The following excerpt, describing what is generally taken to be the discovery of *Magnolia fraseri* (then known as *M. auriculata*) in the mountains of western South Carolina, and still one of the best available descriptions of the plant, is a good example of the style which make the *Travels* such a delight to read (Bartram, 1792, pp. 337–8).

> This exalted peak I named mount Magnolia, from a new and beautiful species of that celebrated family of flowering trees, which here, at the cascades of Falling Creek, grows in a high degree of perfection: I had, indeed, noticed this curious tree several times before, particularly on the high ridges betwixt Sinica and Keowe, and on ascending the first mountain after leaving Keowe, when I observed it in flower, but here it flourishes and commands our attention.
>
> This tree, or perhaps rather shrub, rises eighteen to

> thirty feet in height; there are usually many stems from a root or source, which lean a little, or slightly diverge from each other, in this respect imitating the Magnolia tripetala; the crooked wreathing branches arising and subdividing from the main stem without order or uniformity, their extremities turn upwards, producing a very large rosaceous, perfectly white, double or polypetalous flower, which is of a most fragrant scent; this fine flower fits in the center of a radius of very large leaves, which are of a singular figure, somewhat lanceolate, but broad towards their extremities, terminating with an acuminated point, and backwards they attenuate and become very narrow towards their bases, terminating that way with two long, narrow ears or lappets, one on each side of the insertion of the petiole; the leaves have only short footstalks, fitting very near each other, form an expansive umbrella superbly crowned or crested with the fragrant flower, representing a white plume; the blossom is succeeded by a very large crimson cone or strobile, containing a great number of scarlet berries, which when ripe, spring from their cells and are for a time suspended by a white silky web or thread. The leaves of those trees which grow in a rich, light humid soil, when fully expanded and at maturity, are frequently above two feet in length and six or eight inches where broadest.

The "mountain magnolia," one of the common names for *M. fraseri,* refers to the tree's natural habitat in the southern Appalachian Mountains, extending from Virginia and West Virginia south to Georgia and Alabama. The forests covering these mountains, particularly those in Great Smoky Mountains National Park on the North Carolina–Tennessee border, are well known for the diversity and abundance of the spring-blooming plants they harbor. The annual excursions to the Smokies sponsored by the University of Tennessee are aptly called "Wild-flower Pilgrimages," for to be in that region during late April and early May is an almost transcendental experience for the lover of our native woodland flora. The diversity of species and the abundance of bloom are concentrated in areas known locally as coves or hollows—sheltered areas in a gap between mountains, usually the valley of a crystal-clear and cascading stream. Here many of our hardwood tree species reach their best development and here, in reserves such as the Smokies, we are still able to glimpse the grandeur of what was once the most extensive and magnificent of temperate forests. The mountain magnolia is one of the trees typical of these cove forests, and it grows along with the cucumber magnolia (*Magnolia acuminata*), the tulip poplar (*Liriodendron tulipifera*), the sweet buckeye (*Aesculus octandra*), and the silverbell (*Halesia carolina*).

Although a relatively minor component of the cove forests, *M. fra-*



A specimen of Magnolia fraseri *in bloom in the wild of Ashe County, North Carolina. Unlike other umbrella magnolias, the flowers of this species appear before the leaves have fully expanded. Photograph by R. Weaver, Jr.*

seri is not easily overlooked. The trees normally have several trunks, the smooth bark almost obscured by growths of crustose lichens and leafy liverworts. But the early-unfolding purplish leaves, encircling the saucer-sized, fragrant flowers, stand boldly against the soft yellow-green canopy. Cove forests are found at elevations generally between 1000 and 3000 feet, but *Magnolia fraseri* occasionally grows also at higher elevations in strikingly different situations. In the windswept, cloud covered gaps between the high mountains of this region, which reach their peak in Mt. Mitchell at 6684 ft., *Magnolia fraseri* can also be found. The American beech (*Fagus grandifolia*) is the most common tree here (the places are known locally as "beech gaps"), but *M. fraseri* is occasionally found along with *Aesculus octandra.* Here the trees are stunted, gnarled and covered with lichens, very different in appearance from those of the same species at lower elevations. The leaves are smaller than in the coves below, and it blooms several weeks later. Although the tree looks out of place here, it prospers and its leaves and flowers are surprisingly seldom marred by the effects of wind and cold.

Like those of all its close relatives the leaves of *Magnolia fraseri* are large in size, usually 10 to 15 inches long and 6 inches or more broad. But unlike both its American relation, *M. tripetala,* or its oriental relatives, the base of the leaf is drawn out into two rounded lobes, one on each side of the petiole. These lobes, technically "auricles" or less technically "ears" gave rise to the infrequently used common name "eared magnolia," and to a now incorrect Latin name for the species, *M. auriculata.*

Several foliar features combine to make *Magnolia fraseri* one of the best ornamentals among the umbrella magnolias. The leaves are less coarse than those of its relatives, particularly at flowering time. The first flowers appear while the leaves are still quite small so a tree in bloom is much showier than one of those species in which the flowers appear after the leaves have fully expanded. The unfolding leaves are colored a deep, reddish-purple. In most clones this color fades rapidly, while in others it persists well into the growing season. Unfortunately none of the latter appear to be in cultivation. Finally, *M. fraseri* has better autumnal foliage color than most magnolias. The leaves first turn yellow with the veins edged in golden brown. The brown color spreads to eventually cover the leaf; it varies in intensity almost to mahogany in some individuals but it is never dull and lifeless.

The flowers of *Magnolia fraseri* are its primary adornment. They are pleasantly fragrant and saucer-shaped, with the tepals wide-spreading at maturity, and from 7 to 12 inches across. The nine tepals arranged in two series are normally a pale cream color, but Savage (1976) reports that during cool weather they become yellowish, approaching the color of lemons. In Great Smoky Mountains National Park, near the southern part of its natural range, flowering commences during the last week of April. In the Philadelphia area the trees are normally in full bloom during early May, and in the Boston

The elegant form of a nearly open flower of Magnolia fraseri. *Photograph by R. Weaver, Jr.*

area they bloom from mid- to late May into early June. Judging from herbarium records the blooming period lasts about two weeks in the Boston area.

The flowers are followed by the cone-like fruit aggregates typical of magnolias. In *Magnolia fraseri* these are reddish and 3 to 4 inches long. They reportedly mature around the middle of August, considerably before those of most other *Magnolia* species. However, I collected mature fruits in the central mountains of North Carolina during the second week of September in 1979.

Wild trees normally grow with several separate trunks although most cultivated specimens have only a single trunk which is often branched near the base. Height seldom exceeds 40 feet although the largest known wild specimen in Great Smoky Mountains National Park (measured in 1949) is 65 feet tall with a spread of 54 feet and a trunk circumference of 7 feet, 7 inches. The champion tree in the United States, however, is one cultivated in Philadelphia. In 1968 this tree was 65 feet tall with a spread of 50 feet and a trunk circumference of 8 feet, 4 inches. The largest specimens cultivated in England are of similar proportions. In New England they are generally smaller, probably in response to the relatively unfavorable climate. A plant in the Sargent Road Trust, formerly Holm Lea, the estate of Charles S. Sargent in Brookline, Mass., is currently 33 feet tall. Its age is not certain, but it is probably a fully mature specimen dating from Sargent's time.

The pyramid magnolia (*Magnolia pyramidata*) is closely related to *M. fraseri* and is probably only a variety of that species. It is a plant of

The smooth bark or an unusual single-trunked specimen of Magnolia fraseri *on Professor Sargent's former estate in Brookline, Mass. Photograph by P. Del Tredici.*

the Atlantic and Gulf Coastal Plains from South Carolina to eastern Texas, and therefore its range does not overlap with that of typical *M. fraseri*. The major differences between the two are ones of size, *M. pyramidata* being a shorter, shrubbier plant (although the champion specimen, from eastern Texas, is 60 feet tall) with shorter stamens and fruit aggregates than typical *M. fraseri*. Judging from its natural range, the former plant is probably not as hardy as its mountain counterpart, but it is so rare in cultivation that this statement is merely a guess. It has survived to flowering size in Illinois and Indiana.

Reports concerning the hardiness of *Magnolia fraseri* itself are confusing. Wyman (1965, p. 283) lists the species as being hardy in the Arnold Arboretum Zone 5, which includes Boston, but then describes it as being unreliable in the Boston area. On the other hand, Leach (1973) reports that it was not at all damaged during a severe freeze (−35°F) in his Pennsylvania garden when most all of his other species of magnolia suffered to varying degrees. Few records are available for specimens cultivated in New England. The one on Professor Sargent's former estate, estimated to be 70 years old, has already been mentioned. One specimen, grown from seed from a New Jersey nursery, lived for 68 years in the Arnold Arboretum before it was "disposed of" in 1947; a plant grafted from it lived for 64 years. Both of these plants survived temperatures of −15°F. Since magnolias are comparatively short-lived trees in general, our experience at the Arnold Arboretum would indicate that *M. fraseri* is quite reliably hardy here. At any rate the species occupies a considerable latitudinal as well as elevational range in the wild. Presumably individuals collected from Virginia or West Virginia would be the best ones for cultivation in New England. At present we have seedlings at the Arnold Arboretum collected from three stations in the North Carolina mountains, including one from the northern part of the state. These are being tested for hardiness here and they will shortly be available for testing elsewhere.

Basic culture for *Magnolia fraseri* is similar to that for other magnolias. The plant thrives in a rich, moist, slightly acid soil, and it blooms well in partial shade. It should be planted in a somewhat protected location since the large leaves are sometimes damaged by wind and rain. There are no reports of serious diseases or insect pests, and I have never noticed insect damage to my plant or to wild ones. Growth rate is moderate, and my seven year old plant is now 10 ft. tall. It has not yet flowered, although Treseder (1978) reports that the species usually reaches blooming size in five to six years.

To my knowledge there are no cultivars of *Magnolia fraseri*. However, selections for richness and persistence of purple foliar color, as well as yellow floral pigment could result in plants exceptional in ornamental value and hybridization potential. We at the Arnold Arboretum would welcome any information on exceptional variants of this species.

Magnolia fraseri is presently rare in cultivation, and I know of only two nurseries that presently offer it for sale: Gardens of the Blue Ridge, Pineola, North Carolina 28662; and Little Lake Nursery, P.O. Box 782, Willits, California 95490. Although records at the Arnold Arboretum show that seeds germinate readily after three months of cold stratification, fresh seeds are not easily available. We have not tried to propagate it from cuttings, but all of our attempts at grafting it have failed. Gossler Farms Nursery in Springfield, Oregon, one of the foremost magnolia nurseries in the country, has also reported repeated failure with cuttings and grafts, although these problems can hopefully be overcome with further experimentation.

Many of our fine native plants remain rare in cultivation in our own country for a variety of reasons: overfamiliarity with them as wild plants; lack of commercial availability; ignorance as to culture and propagation; or plain snobbishness. Many are far better appreciated abroad. It is hoped that this article will stimulate more interest in *Magnolia fraseri*, a truly fine native plant, not only among magnolia fanciers but also among the general gardening public.

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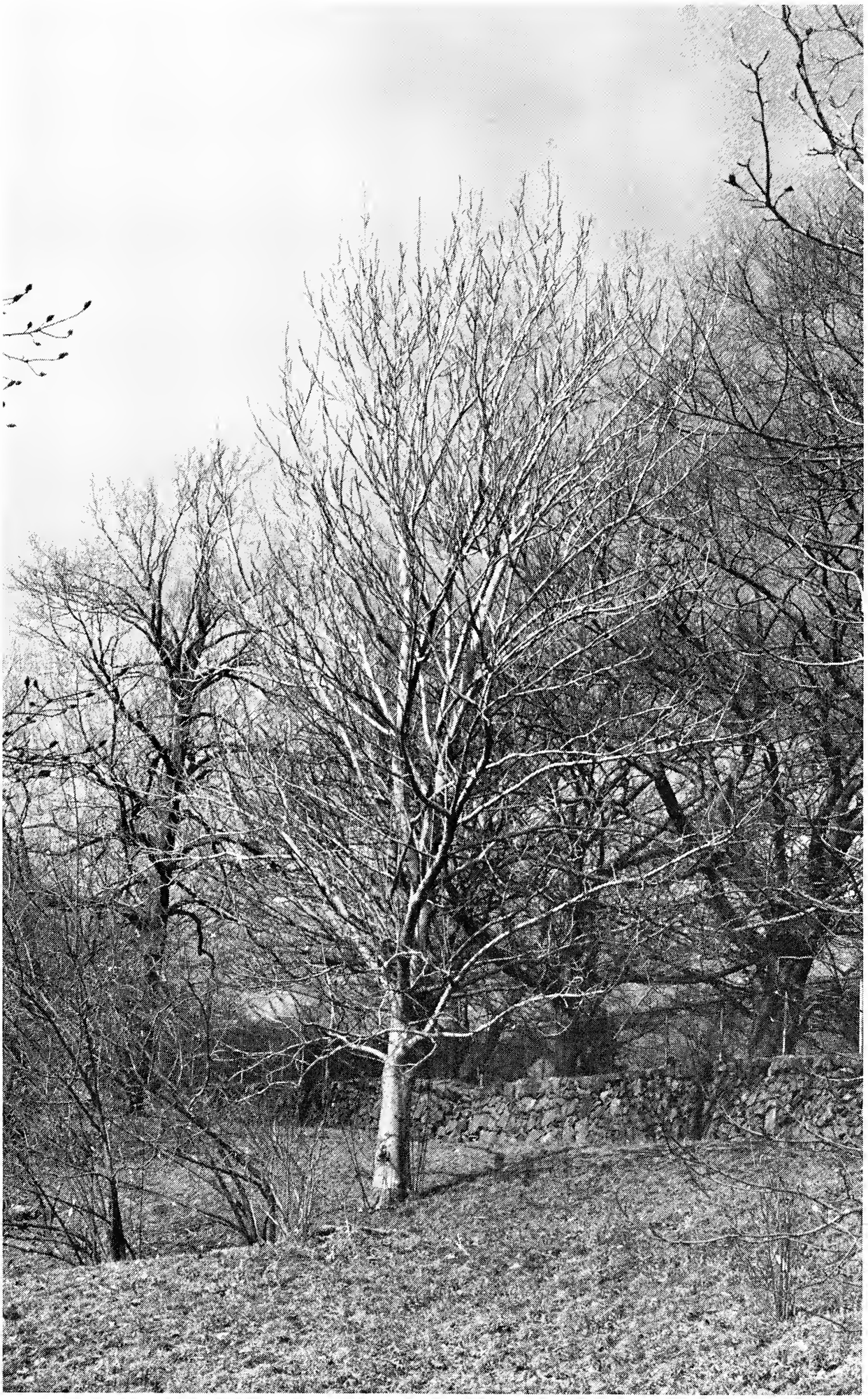
'Silver Parasol' A New Magnolia Cultivar

by S. A. Spongberg & R. E. Weaver

In the Boston area magnolias are generally thought of as small trees or large, twiggy shrubs — early spring-flowering plants that are well adapted for small gardens and urban settings. Rarely, however, are magnolias thought of as large forest trees, yet several species of this diverse genus attain a large size, and in the regions where they are native these species often rate as some of the largest and tallest trees in the forests they inhabit.

The living collections of the Arnold Arboretum include several magnolia specimens that would be considered by most any judge to constitute large trees. These, with one exception, are plants of *Magnolia acuminata* (L.) L., the North American cucumber-tree, and the two specimens that flank the walk to the arboretum's Administration Building are prominent examples. The exception, alluded to above, is a magnolia that grows adjacent to the Arborway wall above the bank of Goldsmith Brook to the right of the main, Arborway gate to the arboretum. Since several large trees of *M. acuminata* grow nearby, the size of this specimen is often not immediately appreciated. For many years this plant, which is grown under Accession Number 1280-27-C, was considered to be a fine example of the Japanese white-bark magnolia, *Magnolia hypoleuca* Siebold & Zuccarini. In



Magnolia 'Silver Parasol' in late winter. The pale pewter-colored bark is one of the tree's outstanding ornamental attributes. Photograph by P. Del Tredici.

eastern Asia *M. hypoleuca* is a prominent forest tree in mountainous regions in the southern Kurile Islands, the four main Japanese Islands of Hokkaido, Honshu, Shikoku, and Kyushu, and southward in the Ryukyu Islands. It attains its best development in the forests on Hokkaido where it grows to be 30 meters (ca. 100 feet) tall, and Charles Sprague Sargent gathered seeds of this species there in 1892. One of the plants of the white-bark magnolia that grew from the seed Sargent brought back to the arboretum was given Accession Number 15172 and planted in the magnolia collection to the east of the Administration Building. Unfortunately, this tree, the only specimen of *M. hypoleuca* that remained in the arboretum's collection that originated directly from Sargent's introduction, had to be destroyed when the service garages and parking lot were constructed adjacent to the Administration Building.

One of the chief characteristics of *Magnolia hypoleuca* and other closely related species is the large size and arrangement of the leaves. While the leaves are usually alternate and widely spaced on new shoots, those on older shoots are crowded into false whorls at the ends of the branchlets. When the leaves fall in autumn, large leaf scars are evident on the stout, brittle branchlets, and Neal Treseder (1978, p. 51) has remarked that "The tree has an almost antediluvian appearance, with its prominently annular-scarred and lenticelled stems."

Other magnolia species that share this unusual leaf arrangement have been grouped with *Magnolia hypoleuca* in *Magnolia* section *Rytidospermum*, and this group includes both Asian and American representatives. The most widespread American species of section *Rytidospermum* is the umbrella-tree or elkwood, *M. tripetala* L., and the first listed common name is an illusion to the arrangement of its leaves on the branchlets. The umbrella-tree is native to rich woodlands in eastern North America from southern Pennsylvania and West Virginia southward into Florida and westward through Ohio and Kentucky to Arkansas and Missouri.

Unlike *Magnolia hypoleuca,* the American umbrella-tree is usually a tree of small stature or more often a large shrub with numerous branches from the base of the plant. Those plants that do attain a tree habit may grow to a maximum height of about 12 meters (ca. 35 feet), and in their native woodlands they are usually understory trees. The bark of the umbrella-tree is ash-gray, while that of *M. hypoleuca* is silvery-gray, and the flowers of *M. tripetala* have an offensive odor while those of *M. hypoleuca* are pleasingly fragrant. Other characters, including those of the fruit aggregates (7-10 cm. long in *M. tripetala*, 13.5-20 cm. long in *M. hypoleuca*), flowers, and leaves, separate plants of these two closely related species.

Several years ago when one of us (Spongberg) was checking the identities of the magnolias in the arboretum's living and herbarium collections, the large tree growing under Accession Number 1280-27-C and passing as a specimen of *Magnolia hypoleuca* posed a dilemma, as it did not agree completely with descriptions and speci-

A fine specimen of Magnolia hypoleuca *at the Arboretum of the Barnes Foundation.* Magnolia *'Silver Parasol' inherited the treelike habit from this parent, but unfortunately not the glaucous leaves so conspicuous in this photograph. Photograph by R. Weaver, Jr.*

mens of *M. hypoleuca*. After a considerable number of comparisons were made, however, it was concluded that the arboretum tree represents an interspecific hybrid between *M. hypoleuca* and *M. tripetala*. In some of its characteristics (especially the flowers and leaves) the arboretum tree is more like the umbrella-tree, yet it had been grown from a seed collected from Sargent's introduction of *M. hypoleuca* (Accession Number 15172),and its large size, its beautiful silvery bark, and its large fruit aggregates suggest that species. Moreover, Sargent's *M. hypoleuca* once grew in close association with arboretum plants of *M. tripetala*, and the opportunity for hybridization was undoubtedly present since both species flower in late May and June after the leaves have fully expanded.

The fact that these two closely related species could hybridize is not surprising since numerous other hybrid combinations are known involving both species, and a *Magnolia hypoleuca* × *M. tripetala* hybrid has been recorded previously from Poland (Vasak, 1973). *Magnolia tripetala* is known to have hybridized with other species of section *Rytidospermum*, including *M. officinalis* Rehder & Wilson var. *biloba* Rehder & Wilson, *M. fraseri* Walter, and *M. macrophylla* Michaux, while *M. tripetala* × *M. sieboldii* K. Koch, an intersectional hybrid, is represented in cultivation by the cultivar 'Charles Coates'. Another intersectional hybrid involving *M. tripetala* and *M. virginiana* is

Foliage and a mature fruit aggregate of Magnolia tripetala, *characteristics of which are inherited by* M. *'Silver Parasol.' From a watercolor by Esther Hines.*

known in cultivation under the collective name *M.* × *thompsoniana* (Loudon) C. de Vos, and was the first magnolia hybrid combination known to arise in cultivation (see Spongberg, 1976). *Magnolia hypoleuca* has also hybridized with other species of section *Rytidospermum,* including *M. fraseri* and *M. macrophylla,* and *M.* × *wiesneri* is the collective epithet for intersectional hybrids between *M. hypoleuca* and *M. sieboldii.*

It is apparent that magnolia hybrids are to be expected when the various species of this ornamentally valuable genus are grown in close proximity in cultivation, and the Arnold Arboretum plant of *Magnolia hypoleuca* × *M. tripetala* is, in our minds, such an outstanding plant that it is deserving of a cultivar name to distinguish it from other plants of the same parentage. In this regard it should be noted that a hybrid plant (perhaps a sister seedling) of reputedly the same parentage is growing at the Hunnewell Estate in nearby Wellesley, Massachusetts, and plants that may have been distributed by the Arnold Arboretum as *M. hypoleuca* may represent this hybrid. We should like to name the plant growing at the Arnold Arboretum and its conal progeny 'Silver Parasol' to draw attention to its silvery gray bark and the parasol-like arrangement of its large leaves.

Magnolia hypoleuca Siebold & Zuccarini × *M. tripetala* L.
'Silver Parasol'

The original tree as of 1 March 1981 is 49 feet (14.8 meters) tall with a spread of 45 feet (13.6 meters). The circumference of the single

A view into the canopy of Magnolia *'Silver Parasol' showing the umbrella-like arrangement of the leaves. Photograph by S. Spongberg.*

The foliage and immature fruit aggregate of Magnolia *'Silver Parasol'. Note their size when compared with a human hand. Photograph by S. Spongberg.*

A fully open flower of Magnolia 'Silver Parasol'. A sweet fragrance compliments the beautiful form and pristine whiteness of these magnificent blossoms. Photograph by H. Howard.

trunk (at 4 feet) is 4 feet, 7 inches (1.4 meters). Its habit is pyramidal, with gently ascending branches, the lowermost originating 6 feet above the ground. The silvery-gray or pewterlike bark is unfissured, even on the oldest wood. It is quite smooth except for the scattered, quarter-inch, diamond-shaped remains of the lenticels.

The leaf blades are elliptic-obovate (narrowly egg-shaped), broadest just above the middle, with an acute to short-acuminate (broadly pointed or abruptly pointed) tip, and a broadly cuneate or occasionally obtuse (broadly triangular) base. At maturity they vary from 12 to 16 inches (30–44 centimeters) in length and in width from 5 to 8 inches (13–21 centimeters), although occasional individuals may be considerably smaller. The undersides of the leaves are slightly grayish and densely short-villous when young; the hairs along the veins are denser, silky, and rather tightly appressed. However at maturity the leaves are glabrescent (nearly hairless).

At the Arnold Arboretum the flowers appear from late May through early June, after the leaves have nearly matured. They are from 8 to 10 inches (20–25 centimeters) across and sweetly fragrant. There are normally 9 tepals, but 12 are occasionally present. The outer 3 tepals are reddish green, and they reflex as the flowers open. The inner 6 (or 9) are creamy-white; at maturity they are held horizontally and the flowers as a result are flat and saucer-shaped. The inner tepals are somewhat variable in shape. The outermost ones tend to be spathulate (tongue-shaped) and these intergrade to ones with an elliptic (oval) blade which narrows gradually at the base to a distinct claw (stalk).

They vary in length from 4 to 5½ inches (11–14 centimeters), and they are about 1½ inches (4–5 centimeters) broad.

The stamens are bicolored, the short filaments crimson, and the much longer anther sacs whitish. The gynoecium (aggregate of carpels) is pinkish, and it retains this color as it matures into fruit. The mature aggregate unfortunately does not assume the beautiful rose color typical of good forms of *Magnolia tripetala* parent, but it is similar in size and color.

Magnolia 'Silver Parasol' most closely resembles its *M. hypoleuca* parent. The most conspicuous differences are in its more nearly elliptic leaves which are only slightly glaucous beneath and in its shorter fruit aggregates, all tendencies toward *M. tripetala*. However its tree-like habit and sweetly scented flowers distinguish it immediately from *M. tripetala*. The plant at the Hunnewell Estate, referred to earlier as a probable sister seedling of 'Silver Parasol' carries tendencies toward *M. tripetala* even further in its more distinctly clawed inner tepals and its leaves glabrescent even when young.

Before its true identity was known, scions of 'Silver Parasol', were distributed by the Arnold Arboretum as *Magnolia hypoleuca*. We would welcome reports on the status of these propagants if any survive, especially as to their hardiness and performance in diverse areas of our country.

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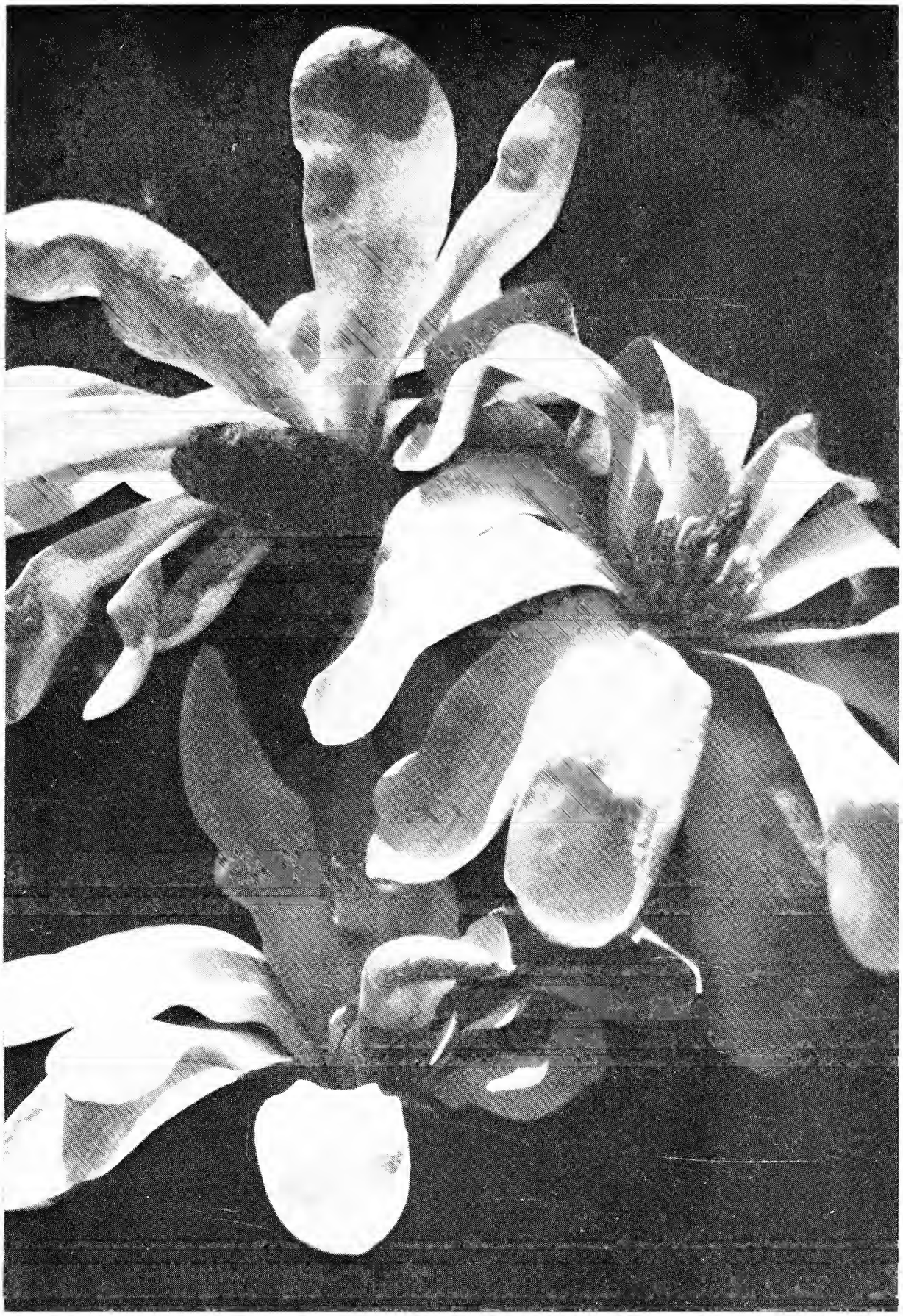
Appendix:

Herbarium specimens that document this new cultivar as well as the plant of the same reputed parentage growing at the Hunnewell Estate, Wellesley, are deposited in the herbarium of the Arnold Arboretum in Jamaica Plain (AAH). These include the following:

Arnold Arboretum:
- S. A. Spongberg 75-31a (3 sheets)
- S. A. Spongberg s.n. May 19, 1976 (5 sheets)
- S. A. Spongberg s.n. May 26, 1976 (6 sheets)

Hunnewell Estate, Wellesley:
- S. A. Spongberg s.n. June 2, 1976 (5 sheets)

Back cover: Mature fruit aggregate of Magnolia virginiana. *Photograph by A. Bussewitz.*



Magnolia kobus *var.* loebneri *'Merrill' is a hybrid between* M. kobus *var.* kobus *and* M. kobus *var.* stellata *and was developed at the Arnold Arboretum. It was named in 1952 by Dr. Karl Sax, director at the time, in honor of Dr. Elmer Merrill, former director. An outstanding ornamental plant combining the best characteristics of its parents,* Magnolia *'Merrill' won for the Arnold Arboretum the Reginald Cory Memorial Cup from the Royal Horticultural Society. Photograph by A. Bussewitz.*

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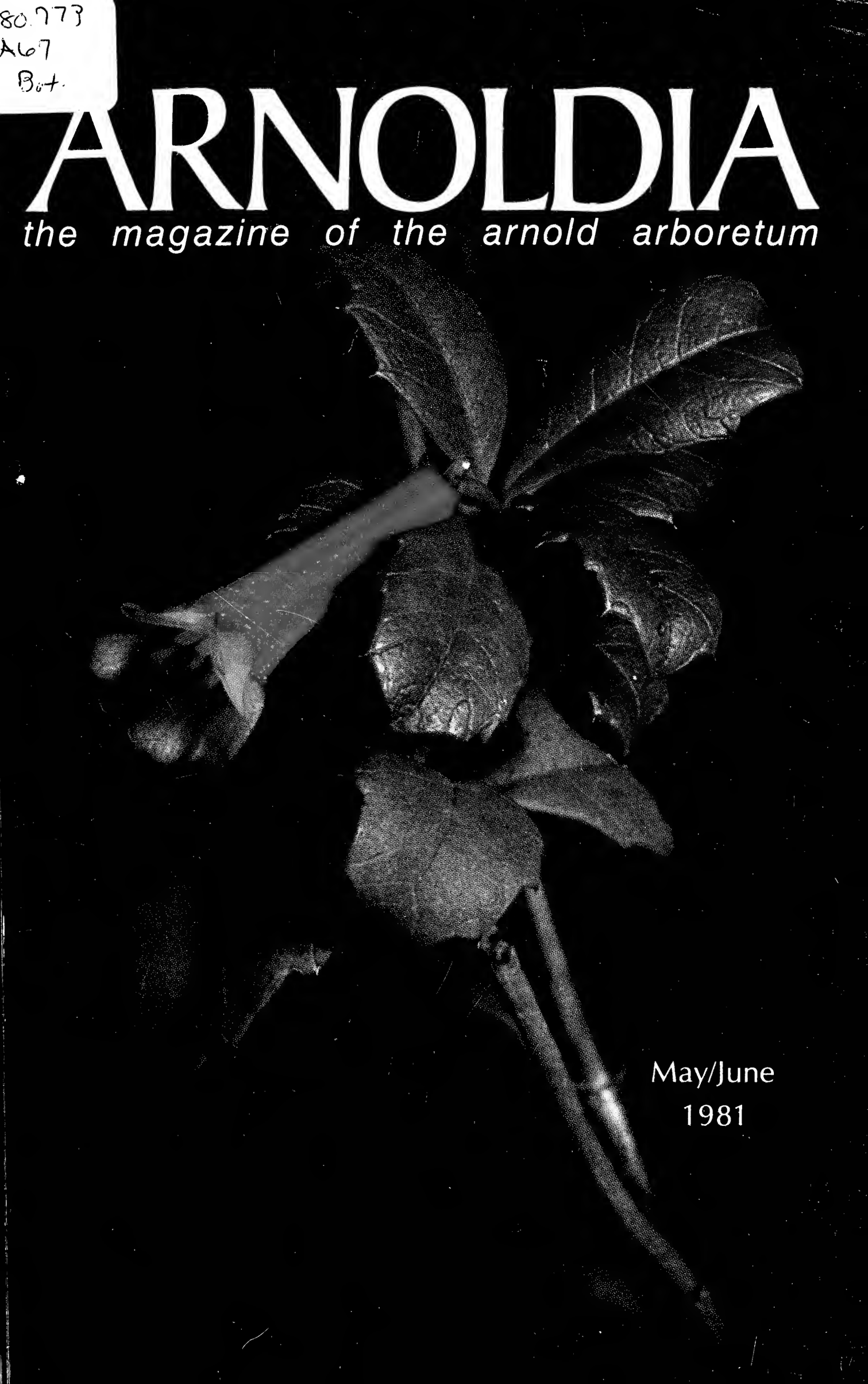

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On the cover: Flowering branchlet of Desfontainia spinosa *of the monotypic family Desfontainiaceae, growing in the Andean highlands of Ecuador. Photograph by J. Hart.*

Iconography of New World Plant Hallucinogens

by Richard Evans Schultes

Our knowledge of hallucinogenic plants of the Americas has grown apace during the past half century. Ethnobotanical understanding of many species long known as hallucinogens has progressed to a remarkable degree. In addition, sundry new psychoactive plants have been botanically identified. Spectacular advances have likewise been made in the phytochemistry of numerous species. Perhaps, however, most encouraging of all has been the realization that constituents of these mind-altering plants may be of exceptional interest as potential medicines in modern psychiatry.

During our botanical and chemical studies of the New World hallucinogenic plants, it has become increasingly clear that some of the species involved have been known in taxonomic circles for many years — long before their use as sacred elements in primitive societies of the Americas was reported.

Ethnobotany, as an integral part of the plant sciences, is basically concerned first with correct identification of species. The earliest botanical descriptions, consequently, assume a vital importance in our understanding of hallucinogenic plants. It was for this reason that I recently published a paper entitled "Hallucinogenic plants: their earliest botanical descriptions", in which the citation of place of publica-

tion of the first description of 188 known or suspected hallucinogenic plants was indicated.

Oftentimes of equal or sometimes of even more importance for the correct identification of a plant is a good illustration. The first post-Linnaean illustrations of the hallucinogenic plants which follow are certainly of historic value, and on occasion they have played a definitive role in the work of identification. These first pictorial representations also have an added significance: of the 28 hallucinogenic genera considered in this paper, a total of 12 or 43% can claim attention as members of the fraternity of horticultural plants.

It is true that illustrations — and sometimes excellent ones — saw publication in pre-Linnaean sources. Frequently, they may be associated with significant ethnobotanical information. It is not unusual for some of these earlier illustrations to play a critical role in the taxonomic determination of an hallucinogenic plant — not uncommonly a more decisive role than depictions published later in post-Linnaean times.

An appreciable number of the illustrations presented in this paper have appeared in rare publications of difficult procurement. When this fact is considered in connection with their importance to ethnobotanical research and the pertinency of several of the species to horticulture, the advisability of publishing such an iconography as this one would seem to be obvious.

The New World is exceedingly rich in species of plants employed in primitive societies for their hallucinogenic or other psychoactive effects. They are found amongst the fungi and the angiosperms. Only a selected few are here considered — those of greatest importance from the point of view of use or of botanical rarity or historical significance. In this iconography, only species of the flowering plants are considered.

It is interesting to note that the New World is much richer in species employed as hallucinogens than the Old World. There are probably 150 species (including fungi) so used in primitive societies in the Americas, and additions to the list are frequently being discovered as ethnobotanical field studies, especially in the tropical regions, progress.

In any consideration of hallucinogenic plants it is essential to remember that primitive societies believe these psychoactive plants to be the "medicines" par excellence, and that their unusual activity which puts man in contact with the spirit world from which comes all death and illness, is due to a resident spirit or divinity. They are considered sacred medicines, not to be abused or taken merely for pleasure.

The enumeration of the families follows the Engler-Prantl system. The genera are arranged alphabetically under the families.

The photography in this article has been made possible by a grant from the National Science Foundation: DEB 75-20107.

MYRISTICACEAE
Nutmeg Family

Virola theiodora *(Spr. ex Benth.) Warburg* in Nova Acta Acad. Leop. — Carol. 68(1897) 187.

Slender tree up to 75 feet tall. Bark with thick reddish resinous liquid. Branchlets red-brown, tomentellous. Leaves papyraceous to chartaceous, sparsely glandular-punctate, oblong to ovate, sinuate, 9–35 cm. long, 4–12 cm. wide. Staminate inflorescences many-flowered, 15 cm. long. Pistillate inflorescences shorter. Staminate flowers pungent, single or in clusters of up to 10. Fruit subglobose, 10–20 mm. long, 8–15 mm. in diameter. Distributed mainly in the western Amazon of Brazil and Colombia and adjacent parts of Peru and Venezuela in well drained forests.

Of the several species of Virola — *V. calophylla* Warb., *V. calophylloidea* Markgraf, *V. elongata* (Spr. ex Benth.) Warb. — employed in the northwest Amazon and the headwaters of the Orinoco, the most important appears to be *V. theiodora.*

This tree and the potent snuff prepared from it have many names amongst the Indians — the best known being epena and nyakwana of the Waikas of northernmost Brazil and adjacent Venezuela.

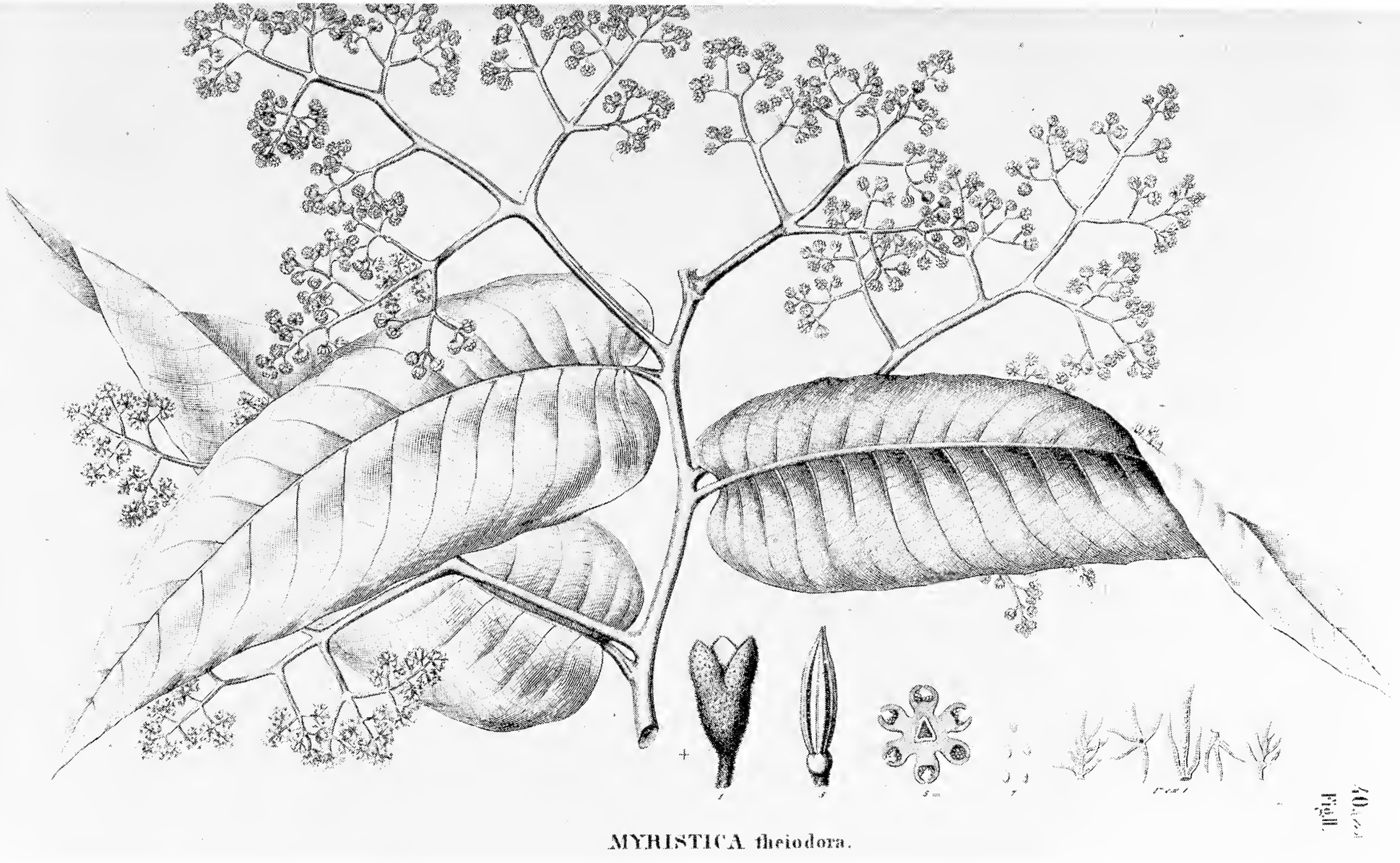
The inner bark has an abundance of a resin-like liquid, colourless but rapidly turning a blood-red on exposure to the air. Preparation of the snuff varies from tribe to tribe. The Waikas usually scrape the liquid from strips of the bark, gather it into an earthenware pot, boil it down to a syrup which is allowed to sun-dry; it is then crushed into a powder and sifted. Occasionally, the pulverized aromatic leaves of *Justicia pectoralis* Jacquin may be added, but the Virola-snuff alone is highly psychoactive and is frequently used with no admixture.

Some Indians prepare the Virola-resin in the form of small pellets for ingestion, and one tribe merely licks the resin with no preparation.

Although the first reference to this hallucinogenic snuff was published in 1923, definitive identification of its source and a description of its preparation were not made until 1954.

The snuff prepared from *Virola theiodora* is rich in several tryptamines — up to 11%; of this, 8% is 5-methoxy-N, N-dimethyltryptamine, hallucinogenically the most active.

The first illustration of *Virola theiodora* was published in 1860.



Virola theiodora (Spr. ex Benth.) Warburg. *Illustrated as* Myristica theiodora *Spruce ex Bentham in Martius, Fl. Bras. 5, pt. 1 (1860) t. 40 bis.*

GOMORTEGACEAE

Gomortega Family

Gomortega Keule *(Mol.) I. M. Johnston* in Contrib. Gray Herb., n. s., 3, no. 70 (1924) 92.

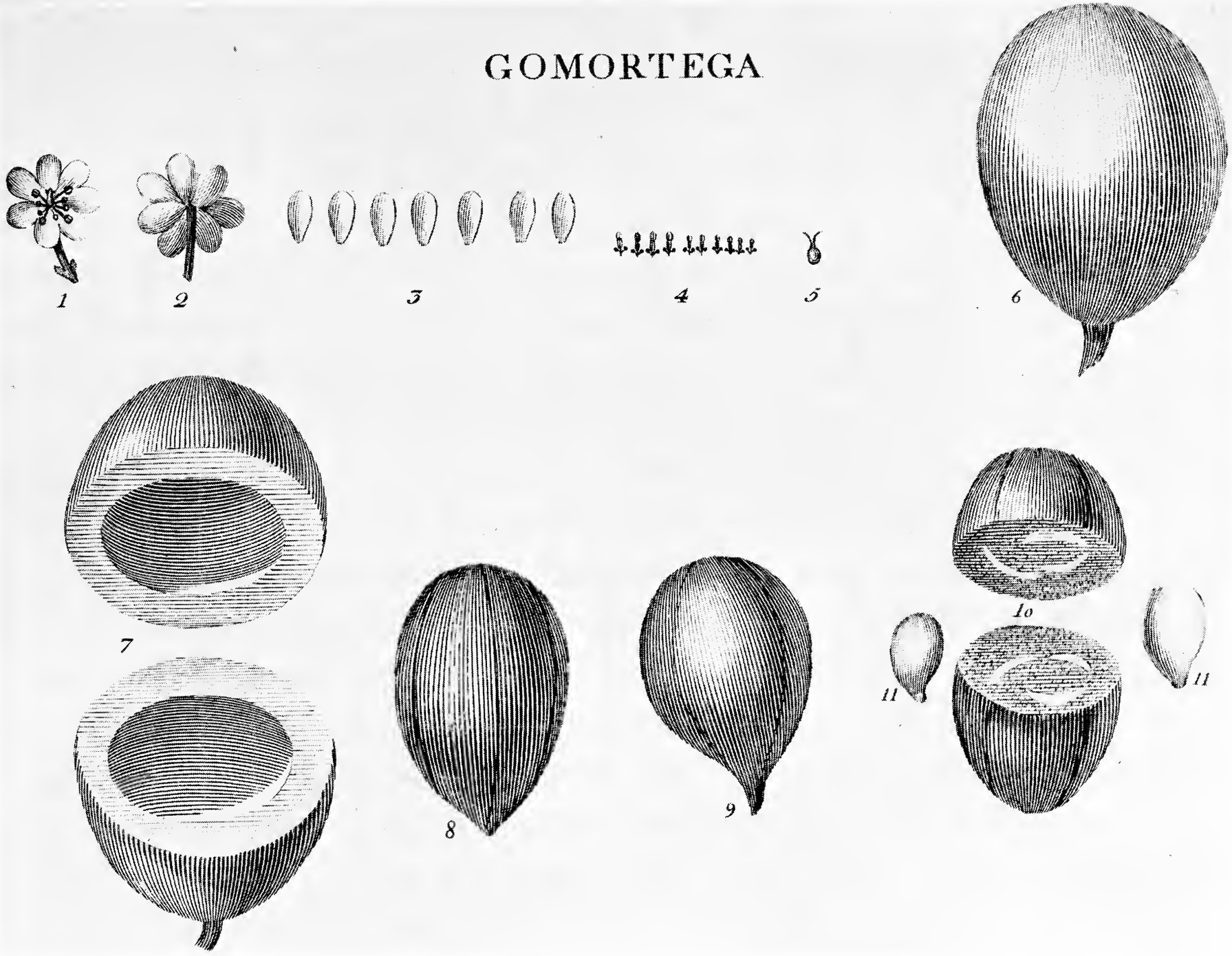
Small, evergreen tree up to 30 feet or more in height. Leaves leathery, glossy, oblong-lanceolate, apically rounded, up to 11 cm. long, 5.5 cm. wide. Flowers small: sepals 7 to 10, spiralled; petals absent; fertile stamens 2 to 3; anthers 2-loculate, opening by valves. Fruit a 1- to 3-celled ovoid drupe, 3.5 cm. long, 2 cm. wide, with a very hard nut.

The Gomortegaceae is a family of one species, a large tree occurring in an area of only 100 square miles in Chile.

Calling this tree *keule* or *hualhual,* the Mapuche Indians of Chile formerly used it as a narcotic: the intoxicating effects may have been hallucinogenic. The Spanish botanists Ruiz and Pavón wrote that the tree is so green and beautiful that it stands out at a great distance. They also remarked that the leaves, which, like the fruits, are rich in essential oils have an acid-astringent taste and that they are so resinous that they stick to the teeth when chewed. Excessive consumption of the fruits, according to these botanists, brings on headaches.

Chemical investigation of this interesting and rare tree has not been reported.

The earliest illustration of this anomalous plant consisted of only flowers and fruits and appeared in 1794.



Gomortega Keule (Mol.) I. M. Johnston. *Illustrated as* Gomortega nitida *Ruiz et Pavón in Ruiz and Pavón, Fl. Peruv. et Chil. Prodr. (1794) t. 10.*

Anadenanthera peregrina (L.) Spegazzini. *Illustrated as* Piptadenia peregrina *(L.) Bentham in Safford in Journ. Wash. Acad. Sci. 6, no. 15 (1916) 548.*

LEGUMINOSAE
Pea Family

Anadenanthera peregrina *(L.) Spegazzini* in Physis 6(1923) 313.

Shrub or tree up to 60 feet tall. Bark thick, corky, grey to black, often armed with stout conical spines or cuneate projections. Leaves bipinnate, 12–30 cm. long; pinnae 10–30 or more, mostly 2–5 cm. long. Leaflets 25–80 pairs, linear, oblong or lanceolate, 2–8 mm. long. Inflorescence compactly globose-capitate with 35–50 very small flowers, 10–18 mm. in diameter. Flowers white: calyx 0.5–2.5 mm. long; corolla 2–3.5 mm. long; stamens 5–8 mm. long. Pods leathery, brownish, broadly linear or strap-shaped, 5–35 cm. long, contracted between seeds. Seeds 3–15, black, glossy, thin, flat, orbicular, 10–20 mm. in diameter. In open grasslands in northern South America and naturalized in the West Indies.

Better known in the literature as *Piptadenia peregrina* (L.) Benth., this tree is the source of a potent hallucinogen. The seeds are toasted and pulverized and mixed with an alkaline ash to produce the snuff known in South America as yopo. It is employed especially by tribes in the basin of the Orinoco. The tree was apparently early introduced from South America to the West Indies, where the snuff was called cojoba. Its use in the Caribbean Islands died out, however, long ago.

An early report of 1496 stated that the Tainos of Hispaniola communicated with the spirit world through this snuff which is "so strong that those who take it lose consciousness. . . . arms and legs become loose and the head drops . . . and . . . they believe that they see the room turn upside down and men walking with their heads downwards."

Several tryptamines and β-carbolines have been found in the seeds of *Anadenanthera peregrina.*

The seeds of another species, *Anadenanthera colubrina* (Vell.) Brenan, are the source of an equally potent snuff used in southern South America, especially in Argentina where it is called cébil or huilca.

The first illustration of *Anadenanthera peregrina* was a photograph of an herbarium specimen published in 1916, when cojoba and yopo were identified as snuffs from the same species.

The first and only illustration of **Mimosa hostilis** (Mart.) Bentham. *Illustrated in R. E. Schultes and A. Hofmann,* The Botany and Chemistry of Hallucinogens, *Ed. 1 (1973) 96, fig. 23.*

LEGUMINOSAE

Pea Family

Mimosa hostilis *(Mart.) Bentham* in Trans. Linn. Soc. 30 (1875) 415.

A bushy treelet, sparsely spinose, with bipinnate leaves 3–4 cm. long, 4– to 6–jugate; pinnae 2.5–3 cm. long; leaflets 1–2 mm. long. Inflorescence loosely cylindrical, measuring 5.5–6 cm. in length. Flowers white, fragrant. Pods sessile or short-stipitate, 3 cm. long. Common in dry areas of eastern Brazil.

From the roots of *Mimosa hostilis,* Indians of Minas Gerais, Bahía and Pernambuco in Brazil — especially the Pankarurús — formerly prepared a potent drink known as vinho de jurema. It was taken in a ceremony, particularly prior to battles, to enhance bravery and experience frightening visions to test men's valor. The use of this psychoactive drug has apparently died out with acculturation or extinction of the numerous tribes of the region.

An early report described the effects of this hallucinogen as follows: they would "see glorious visions of the spirit land, with flowers and birds. They might catch a glimpse of the clashing rocks that destroy men's souls or the dead journeying to their goal or see the Thunderbird shooting lightning from a huge tuft on his head and producing claps of thunder by running about."

The active principle in *Mimosa hostilis* has been shown to be N,N-dimethyltryptamine.

No illustration of *Mimosa hostilis* was published until 1973.

Sophora secundiflora (Ort.) Lagasca ex DeCandolle. *Illustrated in Rev. Hort., ser. 4, 3 (1854) 201.*

LEGUMINOSAE

Pea Family

Sophora secundiflora *(Ort.) Lagasca ex DeCandolle,* Cat. Hort. Monsp. (1813) 148.

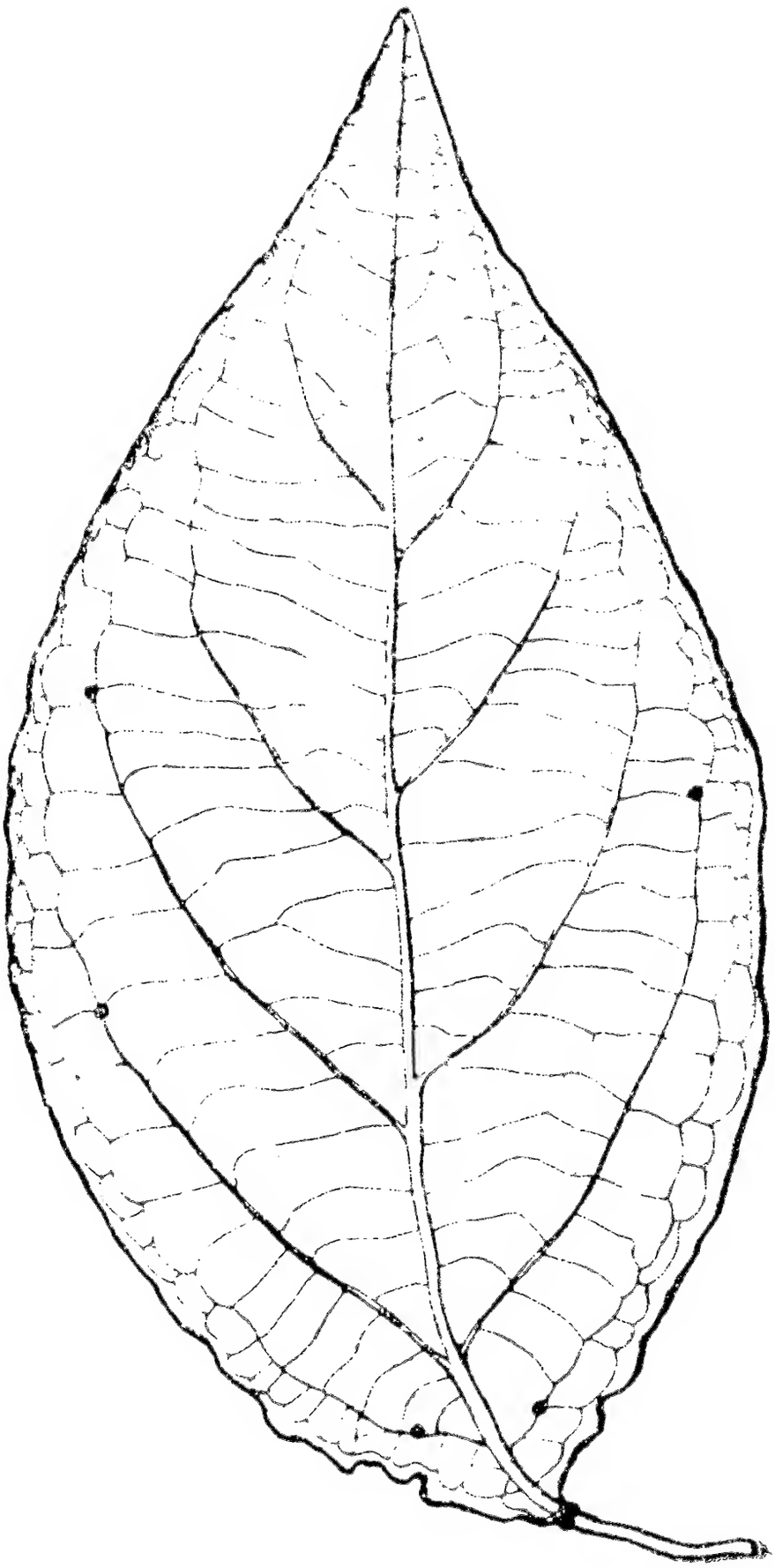
A shrub or small tree reaching a height of 40 feet. The evergreen leaves measure 10–15 cm. in length with 7 to 11 leathery, oblong-elliptic leaflets 1.5–6 cm. long. The flowers, borne in one-sided racemes up to 10 cm. in length, are sweet-scented, violet-blue. The woody, grey-tomentose pods have 1 to 8 bright scarlet, ovoid seeds which measure about 1.5 cm. in length. Ranging from northern Mexico into Texas and New Mexico, along streams in thickets and small groves, usually in limestone areas; it is now widely planted in dry areas of the American Southwest as an ornamental.

The beautiful seeds of *Sophora secundiflora* are known as red beans, mescal beans, coral beans or, in Mexico, frijolillos. They were, in the days before the peyote cactus was adopted as a sacred hallucinogen by Indians of the United States in the mid-1800's, the basis of a vision-seeking cult in the Southwest. These beans are highly toxic, containing the alkaloid cytisine which, in excess, can cause death by asphyxiation. When the safe peyote came north from Mexico as the base of another religious cult, the Indians ceased the narcotic use of the red beans. To this day, however, the priest or "roadman" of the peyote ceremony wears, as part of his ceremonial dress, a necklace of these seeds.

An early Spanish explorer of the Texan coast, Cabeza de Vaca, mentioned the red beans as an article of trade amongst the natives in 1539. Recent well dated archaeological discoveries in northeastern Mexico and Texas have unearthed *Sophora secundiflora* seeds in abundance in several sites ranging between 7000 B.C. and 1000 A.D. Since the red beans are not usable as food, it is possible that they were employed as medicine or, more probably, as ceremonial intoxicants. This possibility is supported to some extent by the discovery of dried peyote in association with the beans in several of the sites.

American Indians of today use the red bean widely as decorations on clothing and artifacts. It seems possible that these seeds, in addition to their beautiful red color, are employed so extensively as adornments because of the respect in which they are held as the result of their intoxicating properties: they are held in special awe as "living, sentient beings, capable of reproducing and initiating action on their own."

The earliest illustration of this beautiful legume was published in 1854 in an horticultural journal.



Banisteriopsis Caapi (Spr. ex Griseb.) Morton. *Illustrated in Hammerman in Bull. Appl. Bot. Leningrad 22, iv (1929) 192.*

MALPIGHIACEAE
Malpighia Family

Banisteriopsis Caapi *(Spr. ex Griseb.) Morton* in Journ. Wash. Acad. Sci. 21 (1931) 485.

Large liana. Bark light chocolate-coloured, smooth. Leaves chartaceous, broadly ovate-lanceolate, acuminate-cuspidate, entire, 8–18 cm. long, 3.5–8 cm. wide. Inflorescence axillary or terminal cymose panicles, 1.5–3 cm. long. Flowers 12–14 mm. in diameter; sepals lanceolate-ovate, densely villous, 2.5–3 mm. long, with or without 8 basal glands; petals pink, cochleate-suborbiculate or ovate, fimbriate, 5–7 mm. long, 4–5 mm. wide, with claw 1.5 mm. long. Samara nut 5 mm. long, dorsal wing semi-ovate, 2.5–3.5 cm. long, 1.2–1.4 cm. wide. Wild and frequently cultivated in western Amazon and cultivated in the Pacific Coastal regions of Colombia and Ecuador.

An intoxicating drink variously known as ayahuasca, caapi and yajé is widely employed as a sacred hallucinogen by many indigenous groups in the western Amazon: Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela and by isolated tribes along the Pacific coast of Colombia and Ecuador.

The bark is either boiled or made into a cold-water infusion. Occasionally other plants may be added to the drink, especially the leaves of another malpighiaceous vine, *Diplopterys Cabrerana* (Cuatr.) Gates, to intensify the effects.

This hallucinogen permeates all phases of life of the Indians; it is thought to reach into prenatal life and operate in life after death. It is taken to diagnose and treat disease and to contact the spirit world in a great variety of magico-religious ceremonies. The Tukanos of Colombia interpret the intoxication as a return to the cosmic uterus during which the trance represents separation of the soul from the body and union with the divinities.

The bark of *Banisteriopsis Caapi* has several β-carboline alkaloids which normally induce an intoxication marked by vomiting, dizziness, excitation or even agitation, eventual desire to sit apart to experience visual hallucinations of bright lightning-like flashes of light to well defined, sometimes frightening visions of spirits, ancestors and animals such as wild cats and boa constrictors.

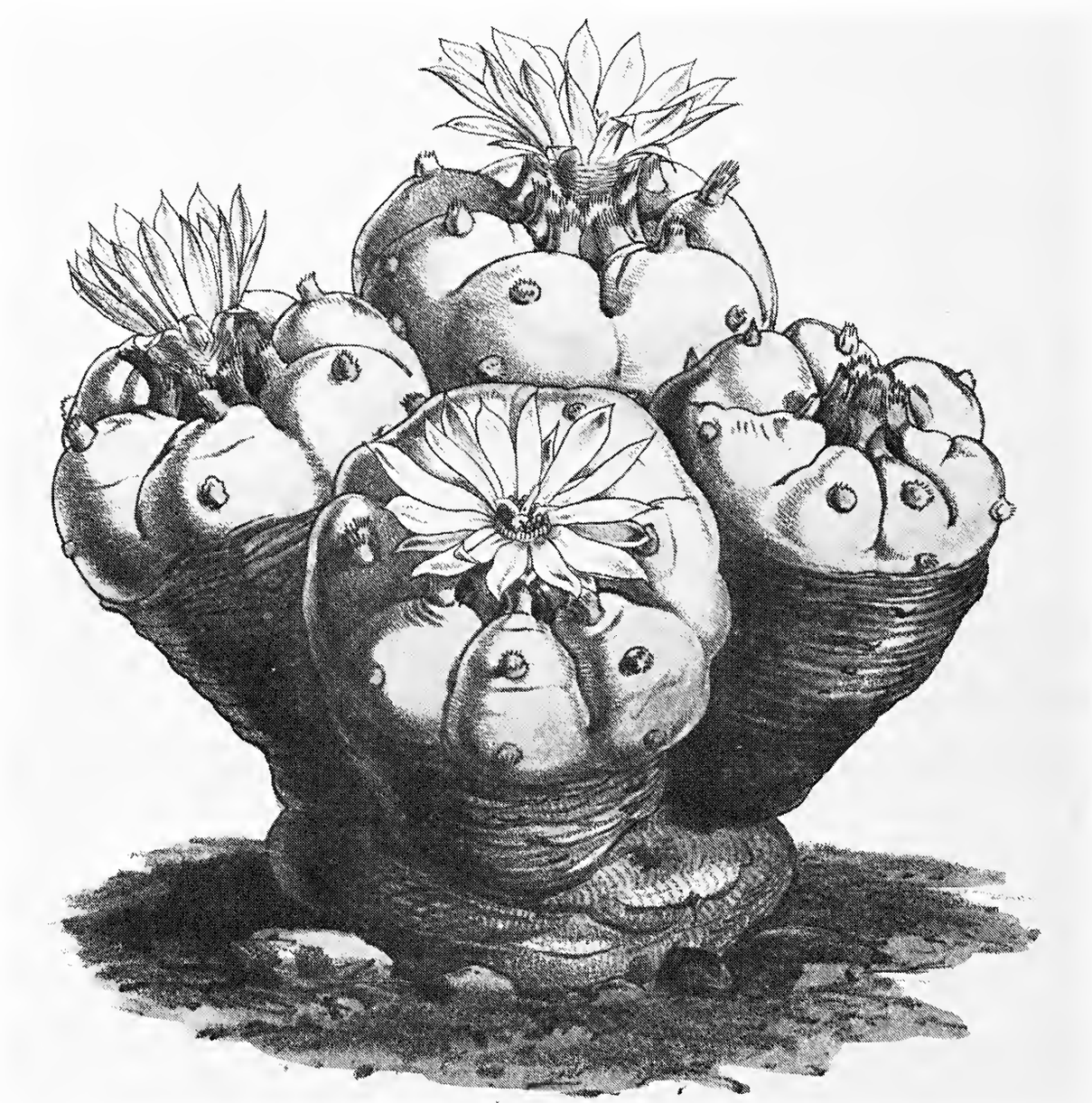
Although the species was described over a century ago, the first illustration, merely a drawing of the leaf, was published only in 1929.

CACTACEAE
Cactus Family

Lophophora Williamsii *(Lem.) Coulter* in Contrib. U.S. Nat. Herb. 3 (1894) 131.

A small, unicephalous or polycephalous, spineless, dull bluish green cactus. Root napiform, 8–10 cm. long. Crown globular, top-shaped or somewhat flattened, 2–8 cm. in diameter, with 7–13 broad, rounded, straight or spiralled, sometimes irregular and indistinct ribs with transverse furrows forming regular polyhedral tubercles; areoles round, flat, with tufts of matted woolly hairs. Flowers solitary, borne at centre of crown, usually pink, rotate-campanulate, 1.5–2.5 cm. across when open. Fruit club-shaped, reddish, 2 cm. long. In calcareous, rocky deserts from central Mexico north to southern Texas.

The Aztecs and other Mexican Indians have long valued the crown of the peyote cactus — usually dried into so called "peyote buttons" — as a sacred hallucinogen. Archaeological artifacts depicting peyote



Lophophora Williamsii (Lem.) Coulter. *Illustrated as* Echniocactus Williamsii *Lemaire in Bot. Mag. 73 (1847) t. 4296.*

and actual specimens over 7000 years old attest to the great age of its use.

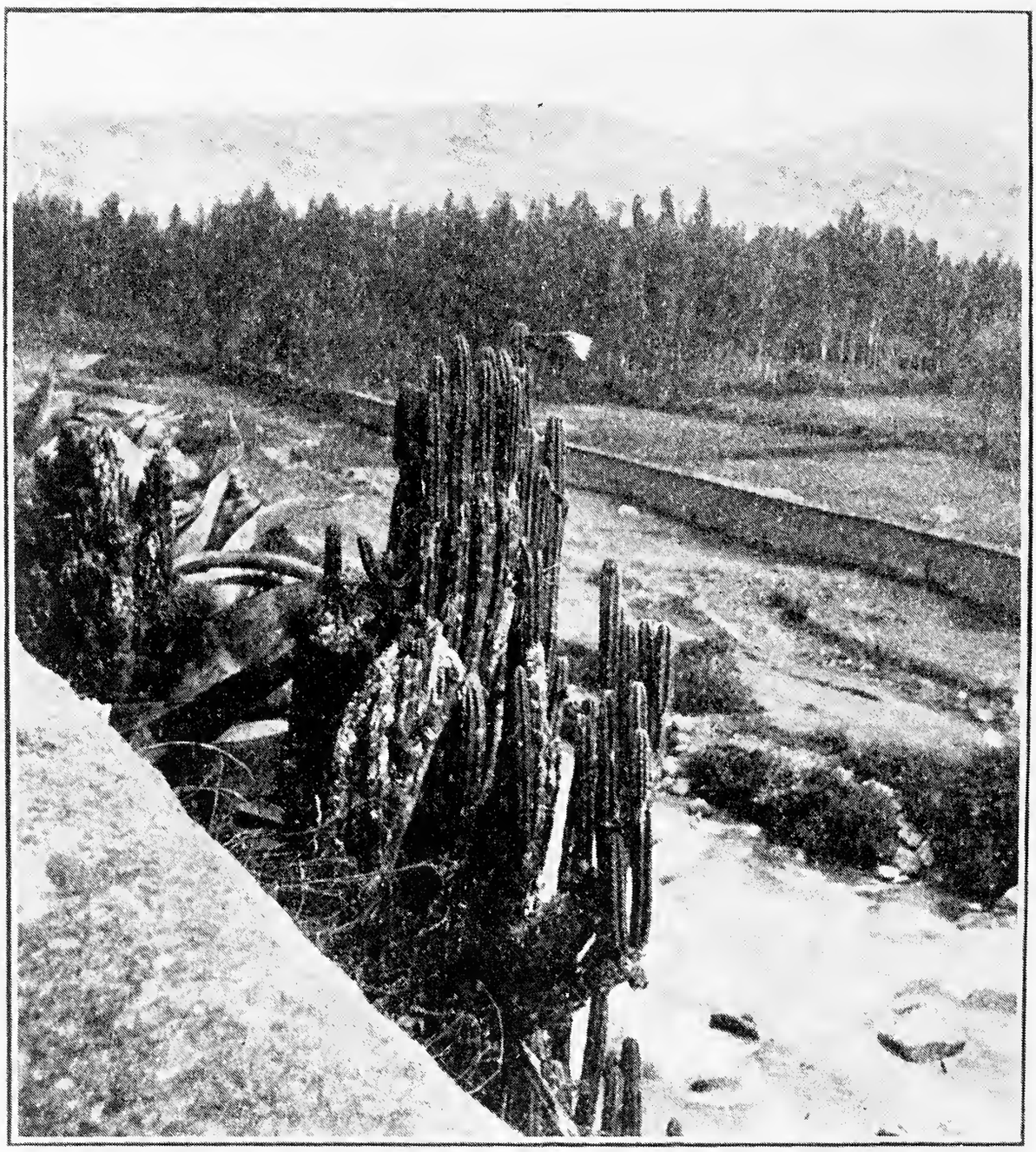
One early Spanish chronicler wrote that, "those who eat of it see visions either frightful or laughable" and that "it sustains them and gives them courage to fight and not feel fear, nor hunger, nor thirst; and they say that it protects them from all danger." Intense persecution notwithstanding, the ceremonial use of peyote persisted. Today, the Coras, Huichols, Tarahumares and other Mexican tribes hold it in great reverence, and it has spread north into the United States and Canada where more than 250,000 Indians in over 40 tribes belong to a peyote-centered cult organized as the Native American Church. Dried peyote-buttons are legally procured through the postal service for use in this religious context.

Peyote intoxication is characterized by indescribably brilliant visual hallucinations in rich colours in kaleidoscopic movement. This effect is accompanied by auditory, tactile, gustatory and olfactory hallucinations, sensations of weightlessness, depersonalization, alteration of time perception, macropsia and other weird aberrations.

Over 30 alkaloids or allied bases occur in peyote. The intense visual hallucinations are due to one: mescaline.

The earliest illustration of *Lophophora Williamsii* — a highly fanciful drawing — appeared in an horticultural publication in 1847. A year later, in 1848, an artistic and very accurate illustration was published in a book on cactus plants. Because of the near simultaneity of these illustrations, both are here published.

Lophophora Williamsii (Lem.) Coulter. *Illustrated as* Echinocactus Williamsii *Lemaire in L. Pfeiffer and F. Otto* Abildung und beschreibung blühenden Cacteen 2 *(1848) t. 21.*



The first illustration of **Trichocereus Pachanoi** Britton et Rose. *A habit photograph of the plant published in N. L. Britton and J. N. Rose,* The Cactaceae 2 *(1920) 135, fig. 196.*

CACTACEAE

Cactus Family

Trichocereus Pachanoi *Britton et Rose,* Cactaceae 2 (1920) 134.

Plant 9–20 feet tall. Branches strict, with 6–8 ribs which are basally broad. Spines few, often absent. Flowers large, 19–23 cm. long, night-blooming, fragrant; outer perianth segments brown-red; inner

segments white; stamen filaments green. Axis of scales on flower-tube and fruit with long black hairs. Cultivated and wild in Ecuador, Peru and Bolivia in the high Andes.

Known in Ecuador as aguacolla, in Peru as San Pedro, this cactus is the base of an hallucinogenic preparation called cimora. Cimora may contain other plant admixtures: *Neoraimondia macrostibas* (Schum.) Britton et Rose, *Brugmansia* spp.; *Pedilanthus tithymaloides* Poiteau, *Isotoma longiflora* Presl, etc.

Cimora is used in an ancient, but recently discovered, ritual connected with magico-religious ceremonies. The modern ritual is heavily influenced by Christian elements.

The active principle in *Trichocereus Pachanoi* is mescaline.

The first illustration of *Trichocereus Pachanoi* is a habit photograph published at the time of the species description in 1920.

Heimia salicifolia (HBK.) Link et Otto. *Illustrated in J. H. F. Link and F. Otto, Enum. Pl. Select. 2 (1822) t. 28.*

LYTHRACEAE

Loosestrife Family

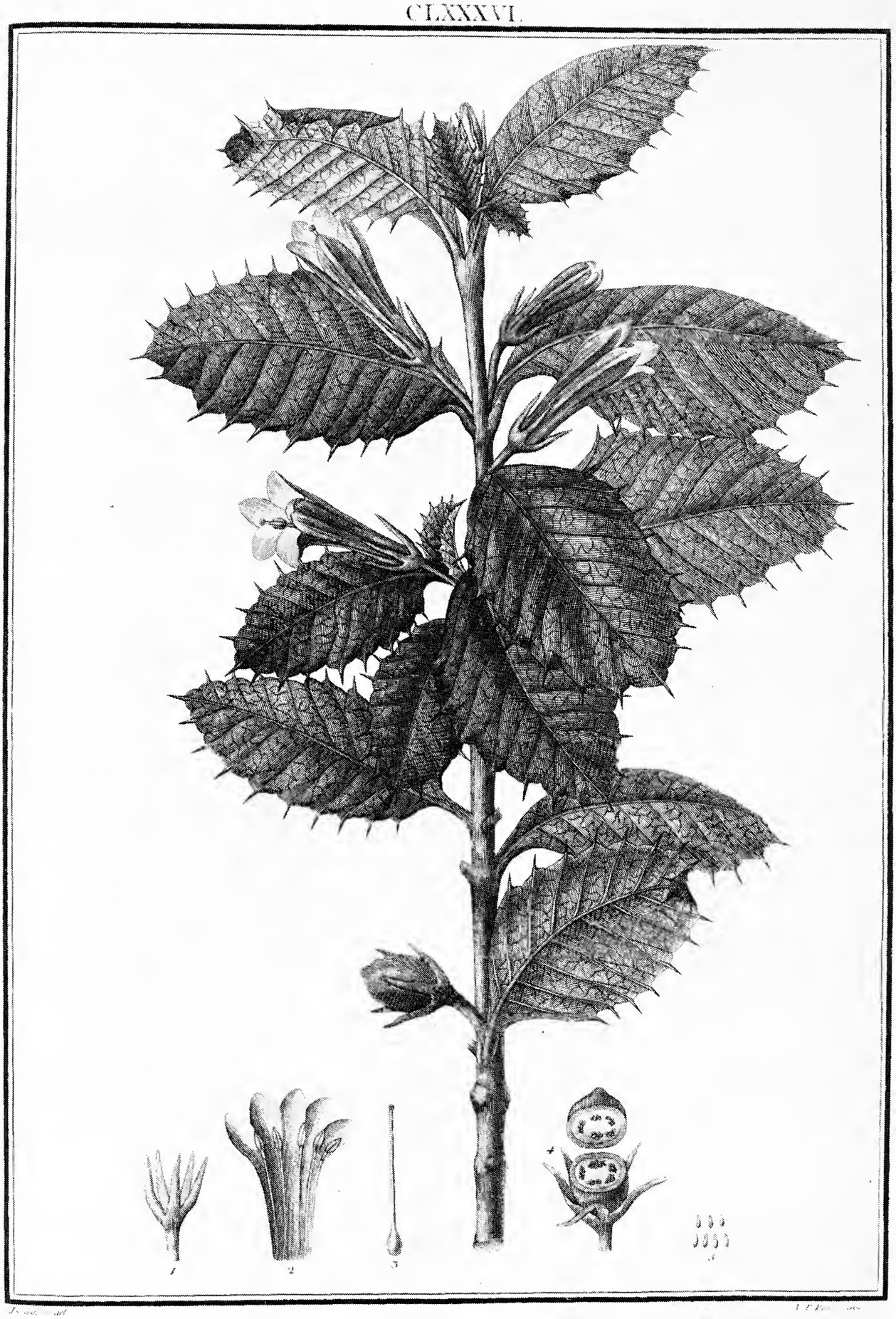
Heimia salicifolia *(HBK.) Link et Otto,* Enum Pl. Select. 2 (1822) 3.

A shrub 2 to 6 feet tall with mostly opposite leaves (some in threes or the uppermost alternate), linear-lanceolate or lanceolate, 2–9.5 cm.

long and yellow flowers solitary in the axils. Common along streams and in damp places in the highlands of Mexico and western Texas, El Salvador, Jamaica and northern South America.

In Mexico, *Heimia salicifolia* is known as sinicuichi. The leaves, slightly wilted, are crushed in water, and the juice is allowed to ferment. The resulting drink is mildly inebriating, inducing a slight giddiness, a darkening of surroundings, shrinkage of the world around, a pleasant drowsiness and deafness or auditory hallucinations with distorted sounds coming apparently from great distances. Mexican natives ascribe supernatural virtues to sinicuichi, asserting that it helps them recall events of the past and on occasion even prenatal happenings.

The first illustration of *Heimia salicifolia* was published in 1822 by the botanists Johann Heinrich Friedrich Link and Friedrich Otto together with the descriptions of the species.



The earliest complete illustration of **Desfontainia spinosa** Ruiz et Pavón. *Drawing in Ruiz and Pavon, Fl. Peruv. et Chil. 2 (1799) t. 186.*

DESFONTAINIACEAE
Desfontainia Family

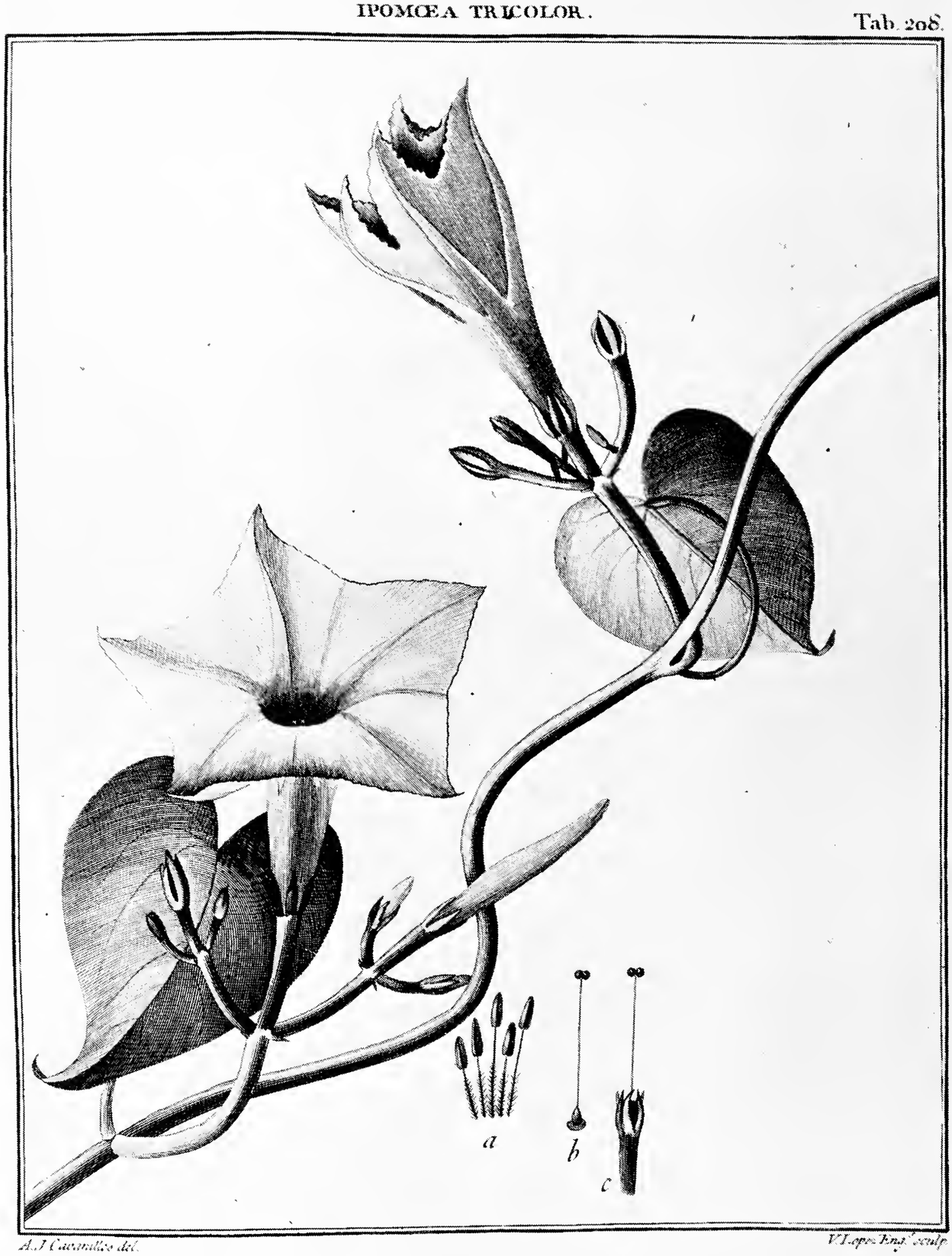
Desfontainia spinosa *Ruiz et Pavón,* Fl. Peruv. et Chile 2 (1799) 47, t. 181.

An erect or semi-scandent evergreen shrub from about 2 to 12 feet in height. Leaves subcoriaceous to coriaceous, dark green, glossy, elliptic to obovate, coarsely sinuate, 1.5–8 cm. long. Flowers solitary or several together. Sepals greenish or brownish green, 5–10 mm. long, 2–4 mm. wide: corolla deep orange or red, yellow within, up to 3 cm. long or longer. Fruit a berry, yellowish, many-seeded, 12 mm. in diameter. *Desfontainia spinosa* is Andean in distribution.

Known in Colombia and Ecuador as *borrachero de páramo* and in Chile and southern Peru as *taique, chapico, michai blanco* and *trautrau,* it is valued as a narcotic by the Mapuche Indians of Chile and by the Kamsá and Ingano medicine men in the Sibundoy Valley of southern Colombia. A tea is made of the leaves when these practitioners "want to dream" or "see visions and diagnose disease." The tea is so potent that it is said to be used infrequently, since it makes the medicine men "go crazy."

Nothing is as yet known of the chemical constitution of this interesting hallucinogen.

The earliest illustration, published by Ruiz and Pavón in 1794, consisted only of flowers. The first complete drawing of the plant appeared in a major work by these same two botanists in 1799.



Ipomoea violacea Linnaeus. *Illustrated as* Ipomoea tricolor *Cavanilles, Icones* 3 (1794) t. 208.

CONVOLVULACEAE
Morning Glory Family

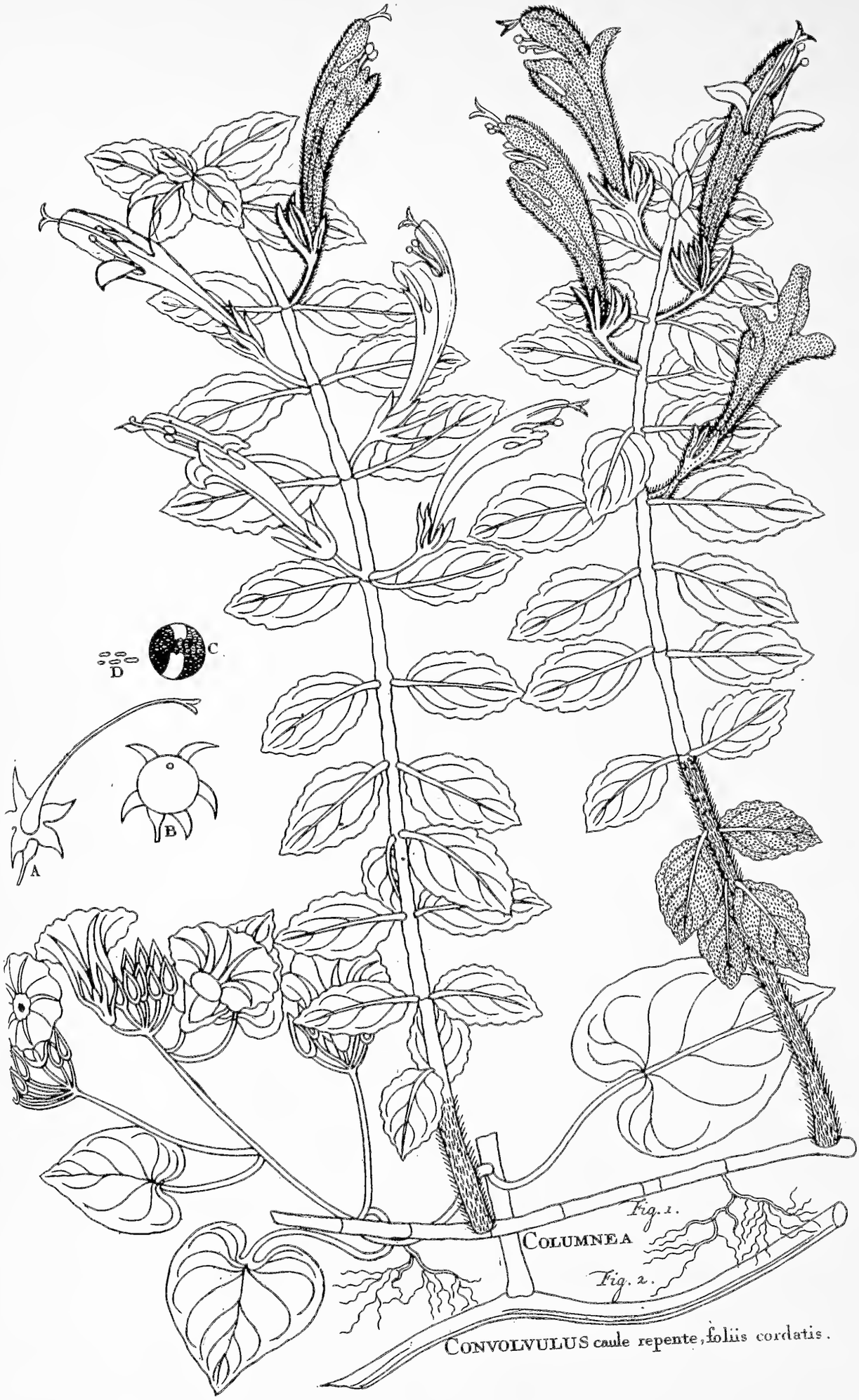
Ipomoea violacea *Linnaeus*, Sp. Pl. (1753) 161.

An annual vine with deeply cordate, ovate leaves 4–10 cm. long, 3–8 cm. wide. The cymose inflorescence has 3 to 4 flowers which are 5–7 cm. wide with a white tube and white, red, purple, violet-blue or blue corolla: limbs often white-spotted. The ovoid fruit measures 13 mm. in length and has jet black angularly ovate seeds 7 mm. long. Ranging through western and southern Mexico and Guatemala, the West Indies and tropical South America.

The seeds of *Ipomoea violacea* — known also as *I. rubrocaerulea* Hooker and *I. tricolor* Cavanilles — are called badoh negro by the Zapotec Indians of Oaxaca, Mexico, who use them as a sacred hallucinogen. These seeds are employed in the same way as those of *Turbina corymbosa* and have the same, though stronger, effects. They contain the same kinds of ergoline alkaloids as does *T. corymbosa* but in much higher concentrations.

It is thought that *Ipomoea violacea* represents the narcotic tlitliltzin of the ancient Aztecs. One of the early Spanish chroniclers, for example, spoke of three inebriating agents: "ololiuqui, peyote and tlitliltzin." This species is the parent of many important horticultural varieties such as "Heavenly Blue," "Pearly Gates" and "Flying Saucers."

This plant was first figured as *Ipomoea tricolor* in 1794.



Turbina corymbosa (L.) Rafinesque. *Illustrated as* Convolvulus caule repente foliis cordatis *in Plumier, Pl. Amer., Ed. Burm. (1756) t. 89, fig. 2.*

CONVOLVULACEAE
Morning Glory Family

Turbina corymbosa *(L.) Rafinesque,* Fl. Tellur. 4 (1838) 81.

Large, woody, perennial vine with ovate-cordate leaves 5–9 cm. long, 2.5–6 cm. wide. Inflorescences congested axillary cymes, usually many-flowered. Flowers fragrant: corolla infundibuliform or hypercraterimorphous, 2–4 cm. long, nearly 3 cm. across when open, white or whitish with greenish stripes; stamens included; sepals enlarged and somewhat ligneous in fruit, about 1 cm. long. Fruit indehiscent, ellipsoidal, 1-seeded, 5–10 mm. long, 4–5 mm. broad, dark brown. Seed roundish, brown 4 mm. × 3–5 mm. with nearly circular scar. Known from tropical and subtropical America: Florida and the Gulf Coastal areas, the West Indies, Middle America and the northern half of South America; naturalized in various parts of the Old World.

The Aztecs and other Indians of Mexico made extensive hallucinogenic use of the seeds of *Turbina corymbosa* in pre-Conquest days: they were called ololiuqui and the vine was known as coaxihuitl ("snake plant"). "The natives communicate with the devil," wrote one Spanish chronicler, "when they become intoxicated with ololiuqui, and they are deceived by the various hallucinations which they attribute to the deity which . . . resides in the seeds." Today, numerous tribes in Oaxaca still employ the seeds in divinatory and healing rituals where, as one writer reported, one finds in almost every village "these seeds still serving . . . as an ever present help in time of trouble."

Indians ingesting these seeds are quickly intoxicated. Visual hallucinations occur following a stage of dizziness and one of a general feeling of ease and well-being, lassitude and drowsiness. Lasting for several hours, the intoxication may end in a stupour.

In 1960, the active chemical constituents of the seeds of *Turbina corymbosa* were shown to be several ergoline alkaloids or lysergic acid derivatives previously known in ergot, *Claviceps purpurea* (Fr.) Tulasne, a primitive fungal parasite of rye, long employed in European medicine and midwifery and the source of occasional outbursts of mass poisonings ("St. Anthony's Fire") when it was inadvertently milled into rye flour and eaten in Europe.

Although ololiuqui was accurately figured in early Spanish writings as a morning glory, the use of convolvulaceous seeds as an intoxicant was not known nor was the plant definitively identified until the early 1940's.

This morning glory is perhaps better known as *Rivea corymbosa* (L.) Hallier fil. It has also been called *Ipomoea sidaefolia* Choisy.

The earliest post-Linnaean illustration of *Turbina corymbosa* appeared as *Convolvulus caule repente, foliis cordatis* in 1756.

Salvia divinorum Epling et Játiva-M. *Illustrated in W. A. Emboden, Jr.* Narcotic Plants, *Ed. 1 (1972) fig. 50 (Macmillan Co., New York).*

LABIATAE
Mint Family

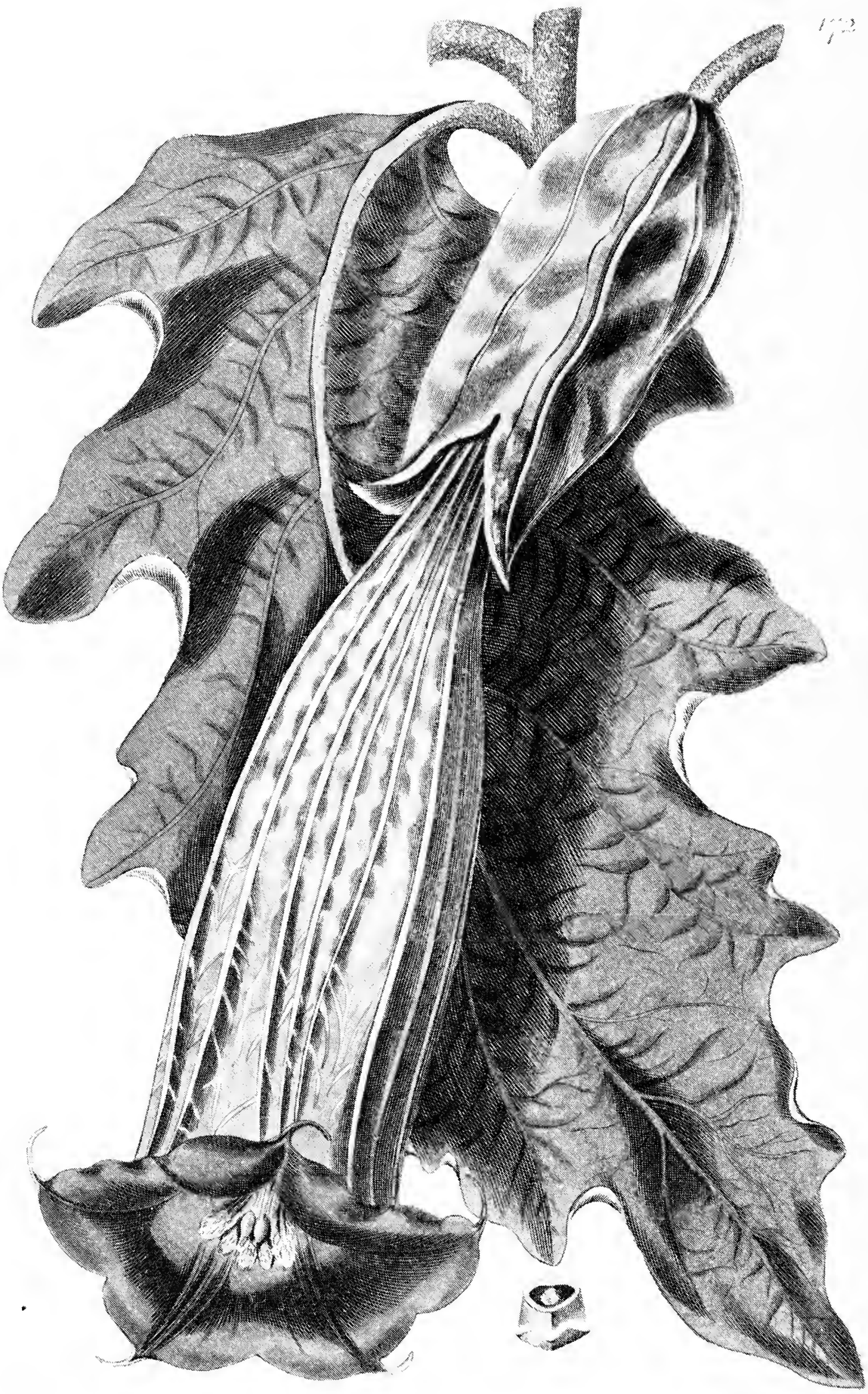
Salvia divinorum *Epling et Játiva-M.* in Bot. Mus. Leafl., Harvard Univ. 20(1962) 75.

Perennial herb, 3 feet tall or taller. Leaves 12–15 cm. long, ovate, crenate-serrulate. Flowers slightly pubescent, in full panicles on branches 30–40 cm. long: calyx tube bluish, 15 mm. long with superior lip 1.5 mm. long; sigmoid corolla 22 mm. long, with superior lip 6 mm. long, inferior lip shorter and incurved; stamens inserted near mouth of tube; style hirtellous, with posterior branch rather long, flat, anterior branch carinate. Known only in cultivation from black soil in forest ravines in northeastern Oaxaca, Mexico, at about 5,500 feet altitude.

The Mazatecs of Oaxaca call this plant hierba de la Virgen or hierba de la Pastora and value it for use in divinatory rites when more potent hallucinogens — the sacred mushrooms and morning glories — are not available. Many Mazatec families cultivate it in hidden plots far from home sites; the plant is vegetatively reproduced.

Although the psychoactive properties of this Salvia have been experimentally verified, chemical studies have thus far failed to identify the responsible principle.

The first illustration of *Salvia divinorum* was a watercolor published in 1972.



The earliest illustration of **Brugmansia sanguinea** (R. et P.) D. Don. *Figured in colour in R. Sweet, Br. Fl. Gard., ser. 2, 3 (1835) t. 272.*

SOLANACEAE

Nightshade Family

Brugmansia sanguinea *(R. et P.) D. Don* in Sweet, Brit. Fl. Gard. 3 (1835) 272.

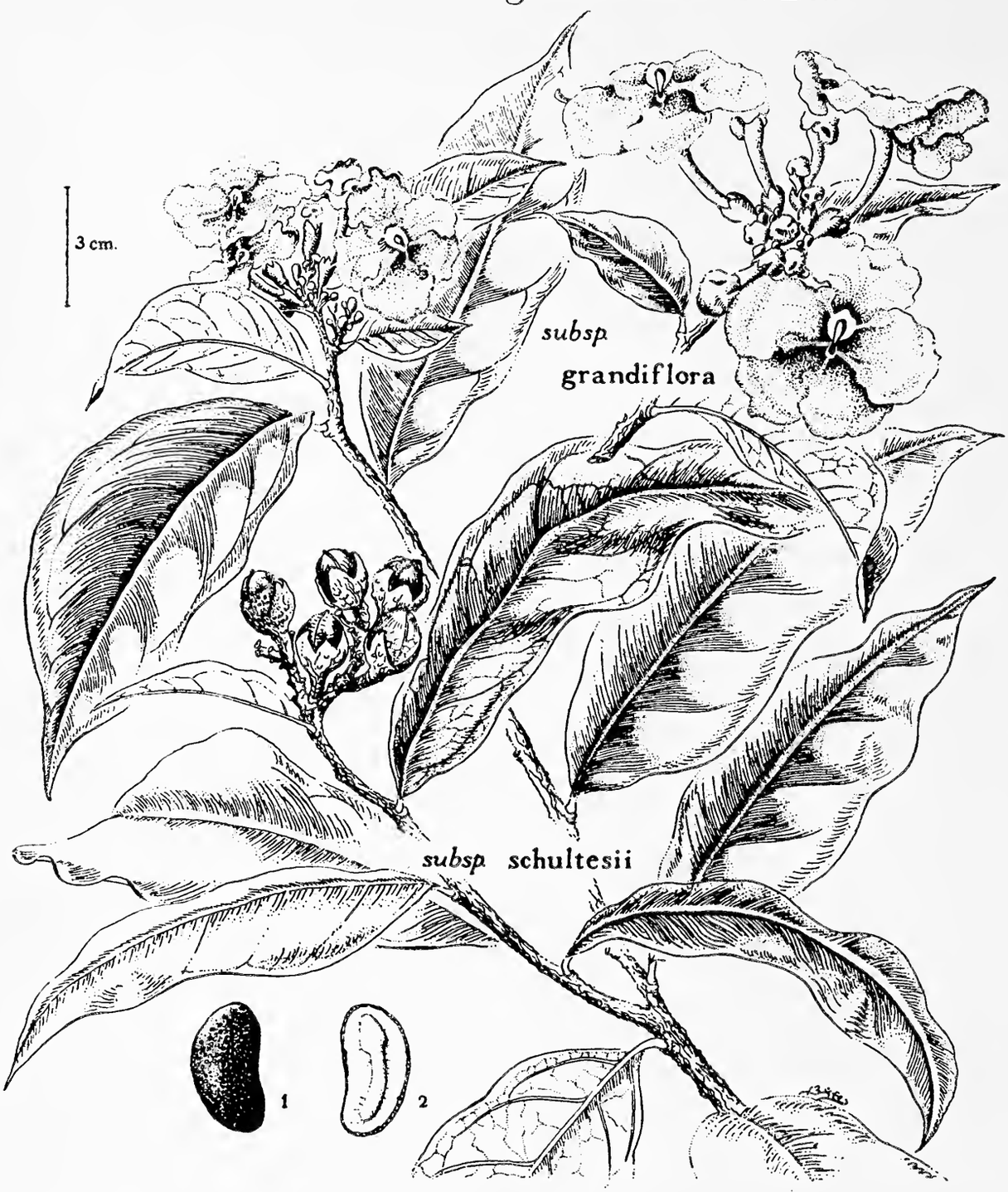
A tree-like shrub up to 15 feet tall with clustered leaves (5 to 7 arising from the same location), narrowly oblong, lightly pubescent, entire or sinuate, mostly 7 to 8 cm. long. Flowers usually 17 to 23 cm. long: calyx one third as long as the corolla; corolla tubular, slightly flaring upwards, blood red or orange red, sometimes yellow, with conspicuous yellow veins. Fruit a top-shaped capsule about 9 cm. long. Native to the highland regions of the Andes from 9000 to 11000 feet.

This beautiful horticultural species is employed as an hallucinogen in many areas of the Andes, where the natives hold it in high esteem as a sacred plant. It is especially valued by Ecuadorian Indians who believe that, during the intoxication which it induces, the soul leaves the body and wanders afar to visit ancestors. In Peru, this plant is called huacacachu or "grave plant", since the Indians believe that it will, through the intoxication, reveal treasure buried in graves or huacas. The pre-Columbian Chibchas of Colombia, where this species is known as tonga, gave a fermented maize drink to which seeds or leaves of *Brugmansia sanguinea* were added to wives and slaves of dead warriors or chieftains to induce a stupour before they were buried alive to accompany their husbands or masters into the after life.

All parts of the plant are highly toxic, containing several alkaloids, especially scopolamine.

Despite its early horticultural attraction, *Brugmansia sanguinea* was not illustrated until 1835. It was described as *Datura sanguinea* by the Spanish botanists Ruiz and Pavón in 1799.

BRUNFELSIA grandiflora *D. Don*



The first illustration of **Brunfelsia grandiflora** D. Don. *Illustrated in Bot. Mus. Leafl., Harvard Univ. 23 (1973) 261, pl. xviii.*

SOLANACEAE

Nightshade Family

Brunfelsia grandiflora *D. Don* in Edinb. New Phil. Journ. (April–October, 1829) 86.

Shrub to small tree, 3–15 feet tall. Bark exfoliating in flakes, buff-coloured. Leaves broadly elliptic to oblong-lanceolate, 6–20 mm. long,

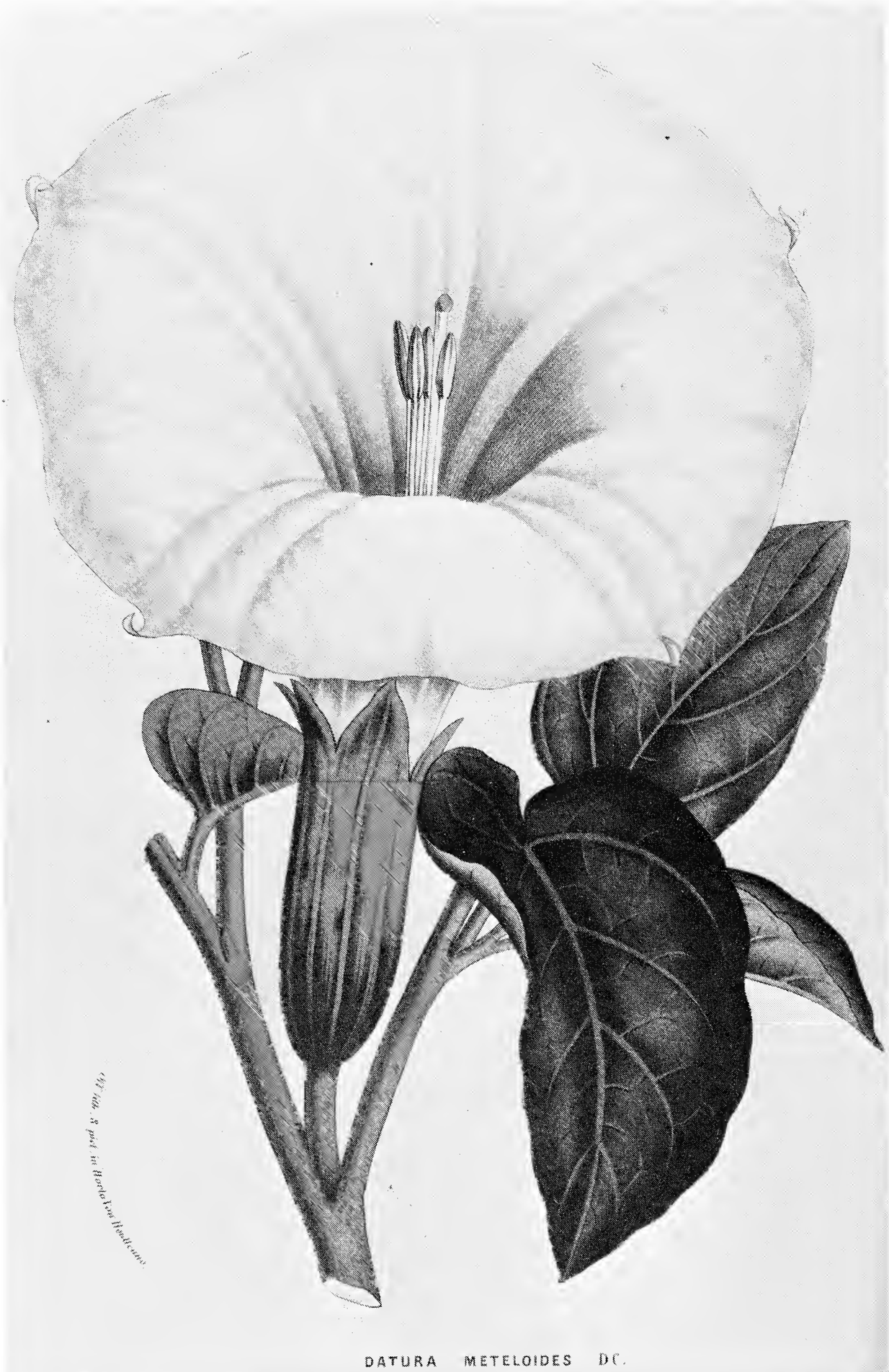
2–8 cm. wide, dark green above, paler beneath. Calyx tubular to somewhat inflated, 5–10 mm. long, persistent. Corolla hypocrateriform, slightly zygomorphic, tube 2 to 3 times longer than calyx, pale violet: limb undulate, 1.5–4 cm. across, rounded lobes 1.2 cm. long, violet to purple with white ring at throat, fading to white with age. Fruit capsular, ovoid to globose, 1.7–2.2 cm. in diameter. A variable species widely distributed in tropical South America in humid forests.

Although members of this genus have long been recognized as toxic and have found wide employment in folk medicine, only recently has real evidence of the use of several species as hallucinogens been found. *Brunfelsia grandiflora* and *B. Chiricaspi* Plowman are valued for their intoxicating properties in Amazonian Colombia, Ecuador and Peru — especially amongst the Kofáns and Jívaros of Ecuador. The leaves and bark are utilized.

The chemistry of Brunfelsia is poorly understood. Whether or not the intoxicating effects are due to an alkaloid or another type of constituent is not known. A nitrogen-free compound, scopoletin, has been reported, but this constituent is not known to be hallucinogenic.

This genus, named for the first great German botanist Otto Brunfels who died in 1534, is a tropical American group of perhaps forty species, several of which are horticulturally important; probably the best known is the yellow-to-white flowered shrub called lady of the night.

Although the concept *Brunfelsia grandiflora* was published in 1829, no illustration appeared until 1973.



Datura inoxia Miller. *Illustrated as* Datura meteloides De Candolle ex Dunal *in Fl. des Serres, ser.* 2, 2 *(1857) t. 1266.*

SOLANACEAE
Nightshade Family

Datura inoxia *Miller,* Gard. Dict., Ed. 8 (1768) *Datura* no. 5.

Plant up to 6 feet tall, usually smaller. Leaves ovate, entire to unequally dentate, flowers white, sometimes slightly violet: corolla funnel-shaped, 10-toothed, 15–18 cm. long; limb 10–15 cm. wide; calyx half as long as corolla with unequal lobes; anthers white, 2 cm. long; style 13–18 cm. long. Capsule globose to ovoid, nodding, 4–6.5 cm. in diameter, with slender spines. Seeds brown.

Known widely by the Mexican name of toloache, this beautiful but highly toxic species has had a long history as a sacred hallucinogen in the American Southwest and Mexico. Many tribes still employ it in ceremonies. The Yumans, for example, value it to induce "dreams" for gaining occult powers to predict the future. The Zunis believe that it belongs to the rain priests who are the only ones allowed to collect it: they put the powdered root into the eyes to commune with the feathered kingdom and chew the root to intercede for rain. The Yokuts take the seeds only once in a lifetime except for boys studying witchcraft who must undergo an intoxication once a year. Many Indians are of the opinion that supernatural powers can be acquired through the effects of this plant.

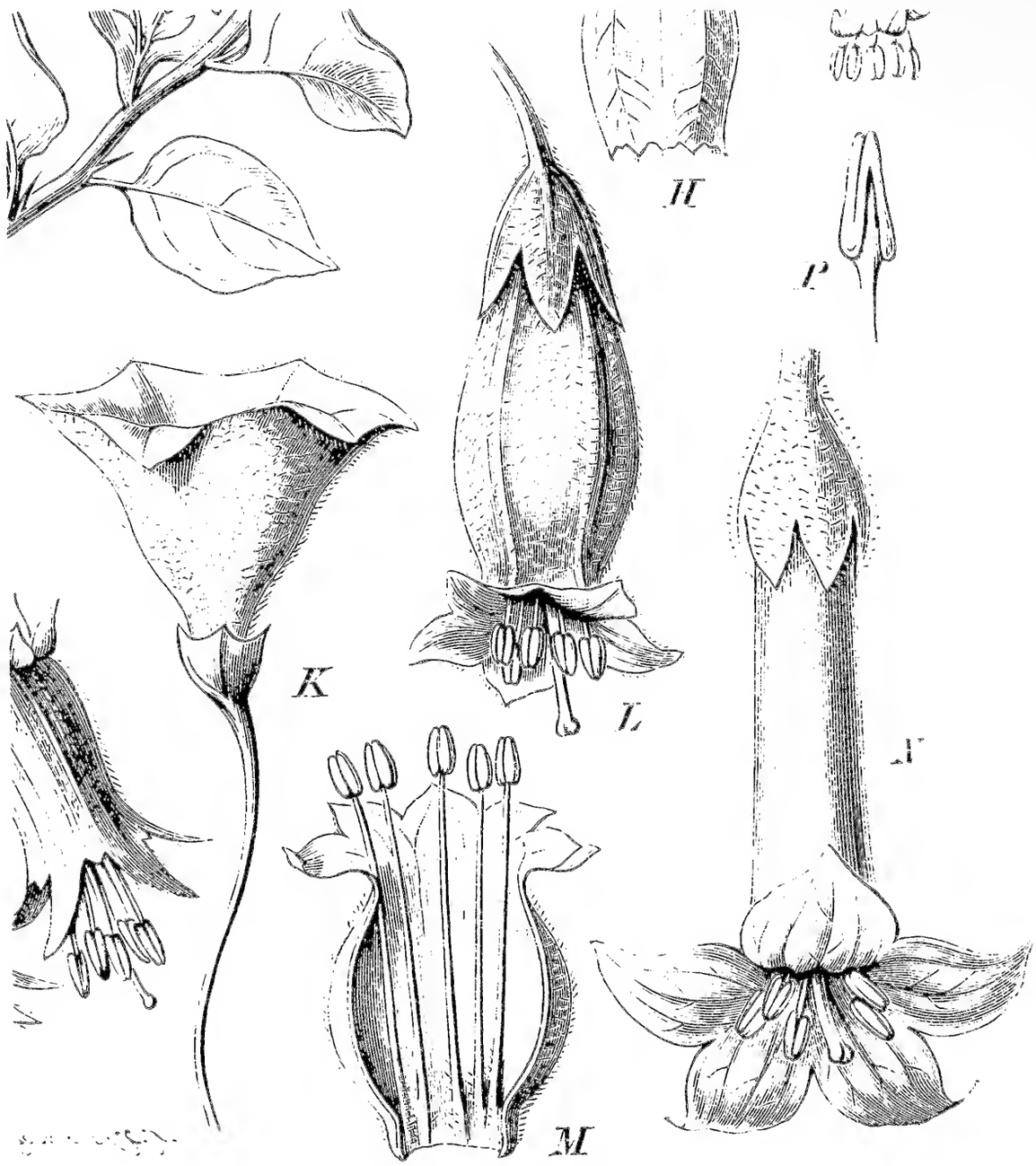
In ancient Mexico toloatzin was often added as an intoxicant to fermented maize beer — a practice still common amongst the Tarahumaras who consider *Datura inoxia* to be an hallucinogen inhabited, unlike peyote, by a malevolent spirit.

Datura inoxia has been more widely known as *D. meteloides* DeCandolle ex Dunal.

There are several other species of *Datura* used in the American Southwest and Mexico. The effects of all of these species are similar and are due to tropane alkaloids, especially to scopolamine.

In the eastern part of North America, *Datura Stramonium* L. was employed as a sacred intoxicant. The Algonquins prepared a powerfully hallucinogenic drink called wysoccan apparently from this species. Boys undergoing adolescent rites were kept intoxicated with wysoccan for long periods during which ". . . they became stark, staring mad, in which raving condition they were kept eighteen or twenty days" to ". . . unlive their former lives" and begin manhood with no memories of their boyhood.

The earliest post-Linnaean illustration of *Datura inoxia* was published as *D. meteloides* in 1857.



Latua pubiflora (Griseb.) Baillon. *Illustrated in A. Engler and K. Prantl,* Natürl. Pflanzenfam. *4, iii B, (1891) 12 (L,M) — flower only.*

SOLANACEAE

Nightshade Family

Latua pubiflora (*Griseb.*) *Baillon,* Hist. Plantes 9 (1888) 334.

Shrub or small tree, 9–30 feet tall. Bark thin, reddish to greyish brown, streaked with fissures. Branches spiny: spines in leaf axils, 2 cm. long. Leaves elliptic to oblong-lanceolate, acute, entire to serrate, 3.5–12 cm. long, 1.5–4 cm. wide. Calyx campanulate, persistent, 8–10

mm. long, green to purple; corolla larger than calyx, urceolate, 3.5–4 cm. long, 1.5 cm. in diameter at middle, densely pilose, magenta to red-violet. Fruit fleshy, globose, 2 cm. in diameter, green to yellow. Growing in humid forests in central Chile between 1500 and 2000 feet in altitude.

Mapuche Indian medicine men in Chile formerly employed this highly toxic plant in folk medicine and malevolently as an hallucinogen. It caused delirium and permanent madness. The doses were a closely guarded secret. The plant apparently was not ritualistically used.

The leaves contain high percentages of hyoscyamine and scopolamine.

Although the concept *Latua pubiflora* was first published in 1854 as *Lycioplesium pubiflorum* Grisebach, it was not illustrated until 1891, when drawings of the flowers alone were published.

The first drawing of **Methysticodendron Amesianum** R. E. Schultes. *Illustrated in Bot. Mus. Leafl., Harvard Univ. 17 (1955) pl. I.*

SOLANACEAE

Nightshade Family

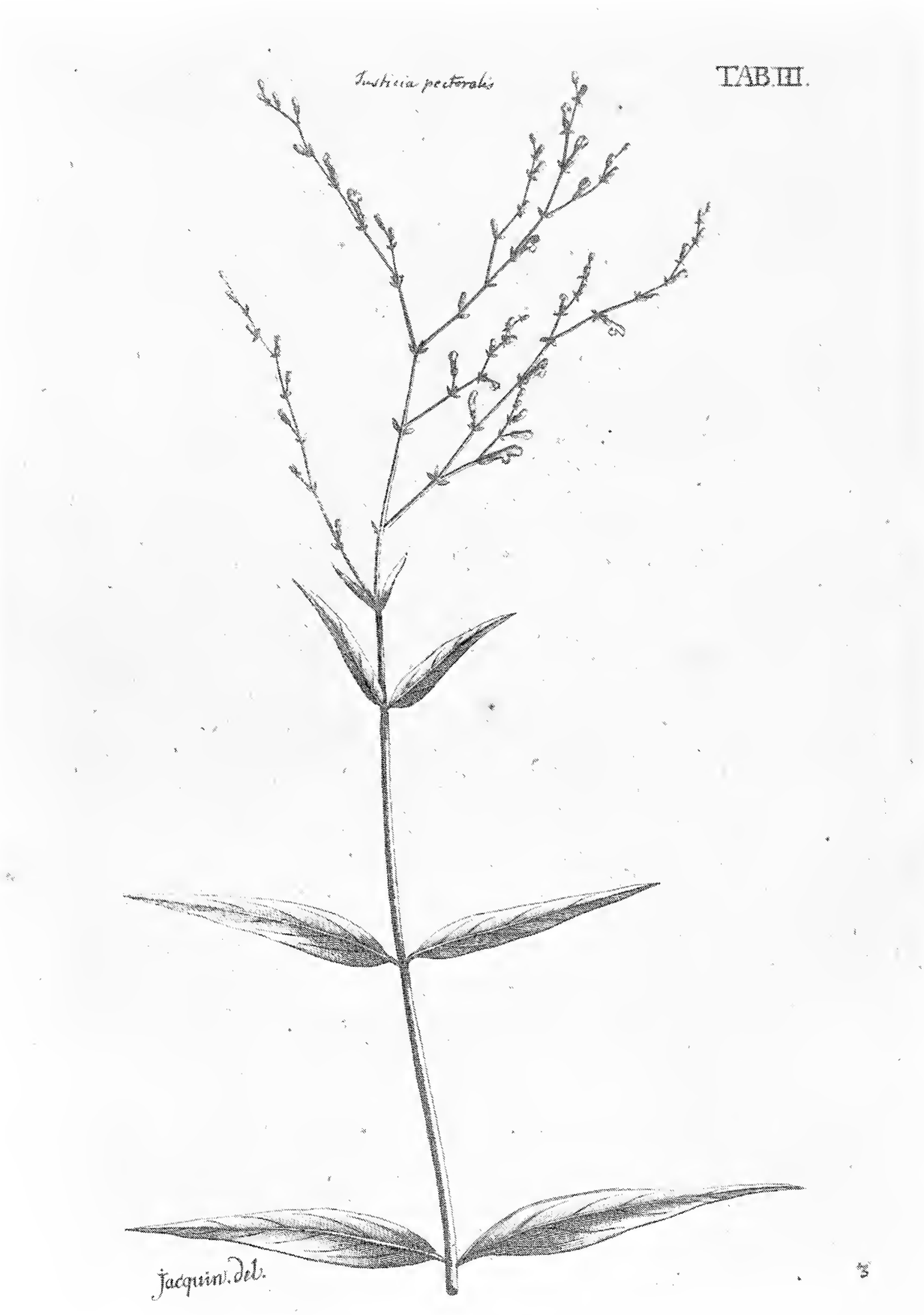
Methysticodendron Amesianum *R. E. Schultes* in Bot. Mus. Leafl., Harvard Univ. 17 (1955) 2.

Tree up to 25 feet tall. Leaves membranaceous, very narrowly ligulate, marginally subundulate, minutely pilose on both surfaces, 20–26 cm. long, 1.3–2 cm. wide. Flowers up to 28 cm. long, apically opening to a width of 10–13 cm., strongly fragrant at sundown: calyx spathaceous, green; corolla divided 3/5 to 4/5 its length, usually with five lobes, white, spathulate, long acuminate, circinate, 14–16 cm. long. Known only from the Valley of Sibundoy in southern Colombia at about 7,500 feet.

The Kamsá and Inga Indians of Sibundoy in southern Colombia use numerous solanaceous plants as hallucinogens, the most potent of which is *Methysticodendron Amesianum.* A drink prepared from the leaves and flowers serves as a medicine and as a narcotic employed in the diagnosis of the cause of sickness and death, to find lost articles and in the practice of witchcraft in general. The strong effects of the plant are due to its high content of scopolamine.

This plant is an enigma. Some doubt exists that it represents a genus distinct from *Brugmansia.* Reproduced vegetatively, it may be an extremely aberrant clone of a *Brugmansia* to which genus it is obviously closely akin. One investigator called it *Datura candida* (Pers.) Safford cv. Culebra Bristol; it has also been suggested that it represents a cultivar of *Brugmansia aurea* Lagerheim. It has further been intimated that it is a species of *Brugmansia* highly atrophied as a result of viral infection, but there is no proof of this possibility. Another explanation holds that it has resulted from the action of a single pleiotropic gene mutation and that it represents only a monstrosity of a species of *Brugmansia.* Until the problem finds a solution and it can be referred to a definite species of *Brugmansia* without any doubt, recognition as *Methysticodendron* would seem to be warranted.

The first botanical illustrations of *Methysticodendron Amesianum* are drawings published together with the original description of the genus. At the same time, a photograph of the habit and one of the leaves and flowers gathered for the preparation of the intoxicating drink were published (Bot. Mus. Leafl., Harvard Univ. 17 (1955) plates iii (habit), iv (leaves and flowers).



The first drawing of **Justicia pectoralis** Jacquin. *Illustrated in N. J. Jacquin, Sel. Stirp. Am. Hist. (1763) t. 3.*

ACANTHACEAE
Acanthus Family

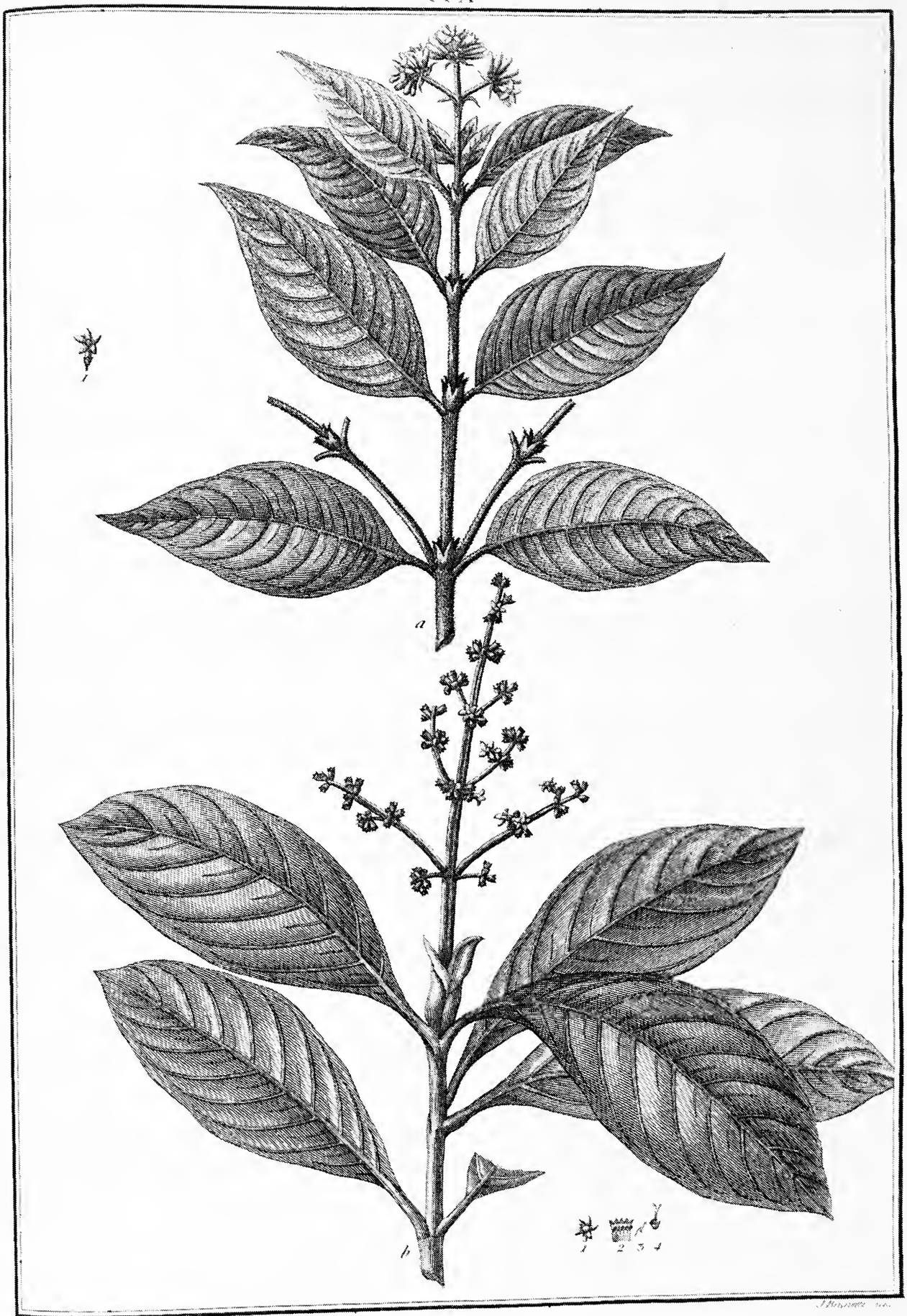
Justicia pectoralis *Jacquin* var. **stenophylla** *Leonard* in Contrib. U.S. Nat. Herb. 31 (1958) 615.

Herb up to 1 foot tall. Leaf blades narrowly lanceolate, 2–6 cm. long, 2–8 mm. wide. Inflorescence often dense, up to 10 cm. long but usually shorter. Flowers small: calyx 2 mm. long, 0.35 mm. wide, puberulous; corolla white or violet, sometimes purple-spotted, 7–8 mm. long. Capsules 8 mm. long. This variety of *Justicia pectoralis* is known only from eastern Colombia and adjacent parts of Amazonian Brazil, where it is frequently semi-cultivated.

Justicia pectoralis var. *stenophylla* is cultivated by Indians of the northwest Amazon for use as an admixture to the snuff prepared from *Virola theiodora*: the aromatic leaves are dried and pulverized. It is known amongst the Waikas of Brazil as mashihari. It is probable that the widespread *Justicia pectoralis,* differing from var. *stenophylla* primarily in having larger and broader leaves, may be similarly employed.

According to some reports, this and several other species are utilized alone in the elaboration of an hallucinogenic snuff. Tryptamines have been reported from several species of *Justicia,* but this report needs confirmation.

The earliest illustration of *Justicia pectoralis* appeared in 1763.



a PSYCHOTRIA *subtomentosa* b PSYCHOTRIA *viridis*

The earliest drawing of **Psychotria viridis** Ruiz et Pavón. *Illustrated in Ruiz and Pavón, Fl. Peruv. et Chil.* 2 (1799) *t.* 210, *fig. b.*

RUBIACEAE
Madder Family

Psychotria viridis *Ruiz et Pavón,* Fl. Peruv. 2 (1799) 61, t. 210, fig. b.

Shrub or small tree up to 14 feet tall. Stipules large, brownish, caducous. Leaves obovate or obovate-oblong, basally long-cuneate, 8–15 cm. long, 2.5–5 cm. wide. Inflorescence terminal, up to 10 cm. long. Flowers sessile in glomerules, very small (usually 4 mm. long), greenish white. Fruit small. Ranging throughout the Amazon basin north to Central America and Cuba.

In several far-separated parts of the Amazon Valley, the leaves of *Psychotria viridis* are occasionally added to ayahuasca, the hallucinogenic drink made from *Banisteriopsis Caapi.* In Ecuador, the Kofán Indians add these leaves "to lengthen and strengthen" the visual hallucinations. In the Acre of Brazil, this additive is likewise used. The Kashinahua of eastern Peru and adjacent Brazil also add leaves of an unidentified species of *Psychotria* to the beverage.

Psychotria viridis apparently is never employed alone as an hallucinogen. The leaves contain the psychoactive N,N-dimethyltryptamine, a compound which is believed to be inactive when taken orally unless it is accompanied by a monoamine oxidase inhibitor. The drink prepared from *Banisteriopsis Caapi* contains β-carboline alkaloids which act as monoamine oxidase inhibitors, so that the tryptamine, when employed as an additive, does alter the intoxicating effects.

The earliest figure of *Psychotria viridis* was published with the description of the species in 1799.

Lobelia Tupa Linnaeus. *Illustrated in Bot. Mag. 52 (1825) t. 2550.*

CAMPANULACEAE

Bell Flower Family

Lobelia Tupa *Linnaeus,* Sp. Pl., Ed. 2 (1763) 1318.

Herb, sometimes basally woody, up to 6 feet tall. Leaves oblong-ovate or oblong-lanceolate, 13–20 cm. long, 3–6 cm. wide, slightly tomentose on both surfaces. Raceme up to 60 cm. long with many

blood-red flowers arising from conspicuous bracts. Calyx green; corolla up to 3.5 cm. long, cleft at back its entire length, the segments apically united; filaments united into a tube, bearing bearded, coherent anthers.

This polymorphic herb of the southern Andes of South America is widely recognized as a toxic species. It is known by its native name tupa and in Spanish as tabaco del diablo ("devil's tobacco"). The plant is esteemed in Chile as a narcotic and as a medicine. Peasants treat toothache with the juice, and the Mapuche Indians smoke the leaves for inebriation. Field research has not yet established the truly hallucinogenic nature of the intoxication, but the plant has definite psychoactive properties.

The leaves contain the alkaloids lobeline, lobelanidine and norlobelanidine.

Lobelia Tupa is one of the most spectacular species of the genus with its scarlet flowers and was early introduced to European horticulture.

The earliest drawing of *Lobelia Tupa* appeared in 1825 in an horticultural publication.

Tagetes lucida Cavanilles. *Illustrated in Cavanilles, Icones* 3 (1795) *t.* 264.

COMPOSITAE

Composite Family

Tagetes lucida *Cavanilles,* Icones 3 (1795) 33, t. 264.

A strongly sweet-scented perennial herb up to 1½ feet tall. Leaves opposite, ovate-lanceolate to oblong-lanceolate, serrulate, punctate with oil glands. Inflorescences 10–12 mm. in diameter, 2- to 3-rayed, yellow to orange. Akenes with a pappus of 2 or 3 short scales and 2 longer awn-like bristles. *Tagetes lucida* is native to Mexico, where it is very abundant in Nayarit and Jalisco.

This relative of our common garden marigold was known to the Aztecs as yahutli and is now called yauhtli in Mexico. According to early Spanish reports, it was powdered and thrown into the faces of captives "to dull their senses" before sacrifices. Today, the Huichol Indians ceremonially smoke a mixture of *Tagetes lucida* and *Nicotiana rustica* L. — a preparation called ye-tumutsali — for inducing visions. Smoking of this mixture is frequently associated with the use of peyote (*Lophophora Williamsii* (Lem.) Coulter) and the drinking of tesguino (fermented maize) or cai (a fermented cactus beverage). Taken with these other psychoactive preparations, ye-tumutsali is said to produce clearer hallucinations but less intense visions. Since this *Tagetes* is usually more abundant than the *Nicotiana,* it is frequently smoked alone for its effects.

The genus *Tagetes* apparently lacks alkaloids. It does, however, possess essential oils, thiophene derivatives, saponines, tannins, cyanogenic glycosides and coumarine derivatives. The chemical constituent responsible for its psychoactivity has not yet been determined.

The Spanish botanist Cavanilles published the earliest illustration of *Tagetes lucida* in 1795.

Inside back cover: The Japanese Lady's-slipper (Cypripedium japonicum), *one of the orchids featured in Richard Weaver's* Exotic Orchids in the Garden, *coming up in the next issue of* Arnoldia. *Photograph by R. E. Weaver, Jr.*

Back cover: Ceramic pot (Chavin culture of Peru, 1200–600 B.C.) with the jaguar associated with pieces of Trichocereus Pachanoi, *the hallucinogenic San Pedro cactus. (Coll. Munson—Williams Proctor Institute, Utica, N.Y.). From* Hallucinogenic Plants, *illustrated by Elmer W. Smith.*

ARNOLDIA

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On the cover: A clump of Bletilla striata *growing outdoors against the foundation of a house. Photograph by R. Weaver.*

Exotic Orchids in the Garden

by Richard E. Weaver, Jr.

"Exotic orchid" would to many people immediately evoke the image of a sumptuous lavender *Cattleya* or a multiflowered spray of brightly colored cymbidiums. But a great number of the more than 20,000 species of exotic orchids are much more modest than these in their coloring and proportions. In fact many cultivated greenhouse species have flowers which are best appreciated with the aid of a magnifying glass. And, while the great majority of orchid species require cultivation in a home or a greenhouse in our climate, an appreciable number are closely related to our own native bog and woodland species, and many of these are hardy out of doors.

Growing orchids in the garden is to me one of the most rewarding of horticultural endeavors. While the number of hardy species is only a small percentage of the total number of known orchids, their diversity in form and size of plant and flower is still considerable. Most are plainly and simply beautiful. Some are of difficult culture, and every good gardener loves a challenge. Others are rare in cultivation and have not been tested for cold hardiness. All of these factors have contributed to the considerable mystique surrounding these plants.

Anyone who has read Paul Keisling's (1981) recent article, on the cultivation of hardy orchids would be amazed at the variety of orchids he grows in eastern Massachusetts. His is a specialty garden, how-

ever, and many of his plants require conditions that few gardeners would be able or willing to duplicate. The species reported on in this article, on the other hand, can be successfully cultivated by anyone with only a little more patience and effort than necessary for growing *Trillium grandiflorum.*

The purpose of this article is twofold: both to report on the successful cultivation of several species which generally have been presumed to be tender, and to stimulate interest in growing these truly exciting plants. Unfortunately very few of the species are readily available from commercial sources in this country so it is necessary to import them from abroad. Although importation requires obtaining a permit, this is a simple procedure, and I provide foreign nursery sources in the appendix to this article. Importation of all orchids is regulated by international agreement, but none of the species included here is rare or endangered in the wild, and the nurseries listed are prepared to provide certification to this effect.

There are a number of precautions to be taken with newly imported orchid plants. First, I have been careful to recommend nurseries that are completely reliable; their plants will be well packed and they should arrive in excellent condition. However, orchids are extremely susceptible to fungal infection and rot. The plants should be carefully unpacked and immediately submerged in a solution of a commercial fungicide for several hours (follow recommendations on the package). Next the plants should be carefully washed in lukewarm water and planted in the garden as soon as possible. Orchid roots are generally delicate and brittle so extreme care should be taken throughout this procedure to avoid damaging them. It is best for the plants to arrive in the late autumn when they are completely dormant; if they are shipped in the spring, they will often break dormancy in transit, and this new growth is particularly susceptible to rot. Plants which arrive in the fall should be overwintered in a coldframe or planted directly in the garden with a heavy mulch. Never try to overwinter them in pots kept indoors. These precautions are not complicated or time consuming, and the results will certainly be worth the effort.

One further word of caution. Seed germination requirements for hardy orchids are still, for the most part, poorly known. Therefore, plants offered for sale have been vegetatively propagated, or more likely collected from the wild. Since most of them increase slowly even in the wild, overcollecting has greatly reduced natural populations of several species. Even though none of the species described here is threatened in the wild, the cultivation of any hardy orchid should only be attempted by the serious and responsible gardener.

Bletilla

Bletilla striata (Thunberg) Reichenbach *f.* (often incorrectly called *B. hyacinthina*) is a rather familiar plant to the American gardening public. In fact, it is sold as the "hardy Chinese orchid" by

Left: Closeup of a flower of Bletilla striata, *showing its* Cattleya*-like form and the frilled ridges on the upper surface of its lip. Below: Part of the clump of* Bletilla striata *growing against the foundation of the southeast side of my house. Photographs by R. Weaver.*

most of the major domestic dealers in daffodils, tulips, gladioli, and other bulbs, mostly from stock grown in and imported from Holland. And unlike many of the other species described later, it is immediately recognizable as an orchid even by the non-gardener since its flowers are entirely reminiscent of the familiar lavender corsage cattleyas in miniature. It is probably the only hardy orchid vigorous enough to be planted in an herbaceous border, although I have not yet quite dared to try it there.

The genus *Bletilla* includes a few rather similar species distributed widely in eastern Asia. *Bletilla striata* itself has long been cultivated in China as an ornamental, but more important, its tuberlike pseudobulbs are used medicinally in that country, and these, when crushed into a paste, are valuable in the manufacture of porcelain. It was introduced into cultivation in Britain in 1803. As is the case with many plants which have been long cultivated, it's natural range is difficult to determine. But *Bletilla striata* still occurs as a wild plant in parts of Japan and China.

The following description is made from plants in my garden. The shoots, which are of annual duration, arise from colorless, tuberlike pseudobulbs usually several inches below the surface of the soil. The canelike stems are from ten to fifteen inches tall, each bearing four to five leaves. The foliage is bold but refined, and remains in good condition for the duration of the growing season. The spreading leaves are prominently ribbed and average eighteen inches long by two-and-a-half inches broad, but may reach to two feet long. The leaf tapers to a long, slender point, and the base forms a sheath around the stem. The inflorescence apparently arises from the apex of the stem and bears five to ten flowers which open in succession from the end of May to the end of June. The flowers are from one-and-a-half to two inches across and uniformly lavender or "orchid" colored, except for the forward half of the lip which is deep purple. The lower, inner surface of the lip is further ornamented with five white, frilled ridges.

Several forms of the species are in cultivation, the best known being the one with pure white flowers (*Bletilla striata* forma *gebina* (Lindley) Ohwi, or as it is usually but incorrectly known, *B. striata* 'Alba'). Although I have never seen a fresh flower, this must be a most beautiful plant. It has a reputation for being less vigorous than the typical plant, and my experience bears this out. Recently Bowden (1980) named three clones ('Anne Axworthy', 'Mrs. Janet Fielding', and 'Mrs. Ruth Verity') of the normal colored form in a rather exhaustive article on the cultivation of the species. No descriptions were provided, although vague mention was made of differences in leaf width and "subtle" differences in the width and color of the floral segments. Basically these clones have proved to be good garden plants, and they were named to differentiate them from recently imported stock which may not be so reliable.

Gardeners vary greatly in their experience with *Bletilla striata*, and a number of my colleagues insist that it is not reliably hardy in the

Boston area. There is undoubtedly considerable variation in hardiness in the stock offered for sale, but Bowden, cited above, has grown all of his named clones, unprotected, in his Simcoe, Ontario garden. I have grown my plants outdoors since 1975 and they were more vigorous than ever after this past winter, the worst in recent memory. Admittedly, they are growing against the foundation on the southeast side of a house — a rather protected location.

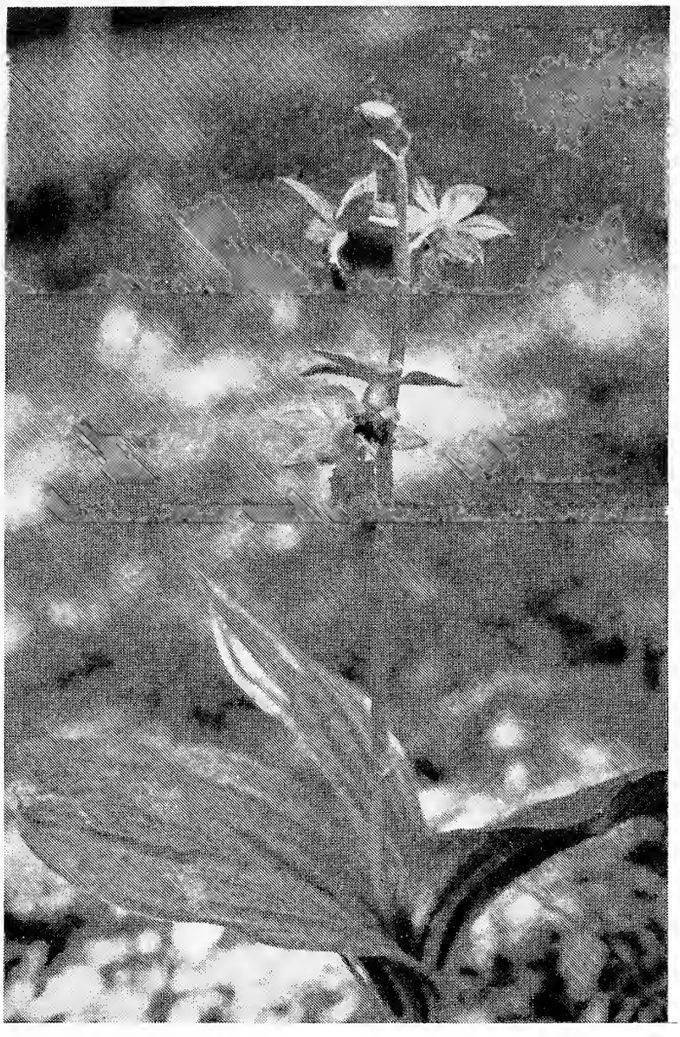
I suspect that failure with this plant is due largely to the inferior condition of readily available stock rather than to lack of hardiness. Most imported material is dessicated to some degree by the time it reaches its destination, and dessication of the pseudobulbs is deleterious. In addition, plants obtained in the spring have often begun growth, and this new growth is highly susceptible to fungal rot. All imported material should be soaked for several hours in a fungicide solution as described in the introduction. A better alternative would be to obtain domestically grown plants, and the few sources of these are listed in the appendix to this article.

My clump has done so well that I have been reluctant to disturb it, even though I am anxious to try the plant in an open garden. For the first several years after it became established the number of shoots doubled annually. The increase has been slower the last two years, and although there was nearly fifty flowering shoots this season, the clump would probably profit from division. The soil is unexceptional, being light and rather sterile, and the site receives the shade of a pear tree for most of the day. For the first several years the plants were mulched heavily with pine needles, but more recently a year-round, one to two inch cover of the same material has been used. I suspect this plant would succeed in most garden situations, except if the soil were constantly wet. I have found it to be one of the most satisfactory plants I grow — beautiful, whether in bloom or not, and completely maintenance free except for a biennial (more or less) application of manure water during active growth and an annual replenishment of the mulch.

Calanthe

The genus *Calanthe* includes perhaps 200 species widely distributed throughout eastern and southern Asia into India, the Himalayas, and Australia. Curiously, a single species is also native to the American tropics. The great majority are tropical or subtropical, and various species and hybrids have long been popular subjects for greenhouse cultivation. In fact the first of the increasing number of artificial orchid hybrids was the Englishman Dominy's cross of *C. masuca* Lindley and *C. furcata* Bateman in 1854.

Calanthes are robust plants with plicate leaves two feet long or more. They are divided into two general groups, deciduous and evergreen, the former of which is more commonly encountered. The deciduous species, represented by *Calanthe vestita* Lindley and its hy-



The general habit of the hardy calanthes, illustrated here by Calanthe tricarinata. *Photograph by R. Weaver.*

brids, have well developed, conspicuous pseudobulbs; the flowering shoot arises separately from the base of the pseudobulb as the leaves begin to wither. The evergreen species, represented by *C. masuca,* have small pseudobulbs which are mostly obscured by the bases of the leaves; the flowering shoot arises from the apex of the pseudobulb, from the fascicle of developing or mature leaves. All of the hardy species belong to the second group.

The name "*Calanthe*" is derived from Greek words meaning "beautiful flower," and the species generally live up to their name. The flowers are variable in size, but seldom more than two inches broad. Generally, the sepals and petals are similar in shape, size and coloration, but sometimes the petals are somewhat narrower. The prominent lip is frequently of a contrasting color, three-lobed, and usually prolonged behind into a spur.

Six or seven species of *Calanthe* are native to the temperate areas of Japan, and several of these also occur in China and Korea. These species were the subject of a short note by Jisaburo Ohwi (the author of the wonderful modern study, *The Flora of Japan* [1965]) which appeared in Baileya (1954). In spite of Ohwi's suggestion that several of these should be hardy in the United States, they are very rarely cultivated out of doors.

In the fall of 1977 Dr. Stephen Spongberg and I travelled to Japan on a seed-collecting expedition for the Arnold Arboretum. On one of our first days in the field we explored the forests near Sapporo, in the

south of Hokkaido, the northernmost of Japan's major islands. This area, which is the meeting grounds for northern and southern elements in the Japanese flora, supports more species of trees than any other place in all of the North Temperature Zone in Japan. The forests are a plant hunter's dream. Trees include the castor aralia (*Kalopanax septemlobus*), katsura tree (*Cercidiphyllum japonicum*), magnolias (*Magnolia hypoleuca* and *M. kobus*), an elm (*Ulmus laciniata*), a *hornbeam* (*Carpinus japonica*), and various maples (*Acer* spp.). From a first glance at the herbaceous cover we might have been in the Great Smoky Mountains of our own country with the numerous ferns, *Trillium,* jack-in-the-pulpit (*Arisaema*), solomon's-seal (*Polygonatum*), lily-of-the-valley (*Convallaria*), mandarin (*Disporum*), wild ginger (*Asarum*), etc. But on closer inspection we found several plants completely unrepresented in the American flora: *Paris,* an odd relative of *Trillium;* the blue Japanese "poppy" (*Glaucidium palmatum*), and several terrestrial orchids with broad, plicate leaves. I collected one of the orchids and brought it home. When it flowered the following spring, it turned out, to my delight, to be the most beautiful of Japan's hardy calanthes, *Calanthe tricarinata.*

Calanthe tricarinata Lindley has an extensive and disjunct distribution from the Himalayas of Kashmir, Nepal and Sikkim, the western Chinese province of Yunnan, and again in Japan where it occurs virtually throughout the Archipelago. The Japanese plants have been considered to represent a separate species, *C. torifera* Schlechter by several authorities, primarily on the evergreen character of their leaves. The differences are very slight and the species are considered synonymous here.

The species was introduced into cultivation from Japan in 1897 by the important English firm of J. Veitch and Son. It has never been common in cultivation, and it was (and probably still is) cultivated primarily as a greenhouse plant. It is the parent, with *Calanthe masuca,* of at least one artificial hybrid, *C.* × *harryana. Calanthe tricarinata* is a very beautiful plant, certainly one of the finest orchids which can be cultivated outdoors in our climate.

It is also among the hardiest of calanthes. I saw it cultivated near Asahikawa, in the center of Hokkaido, where the temperatures have fallen to −40°F (−40°C), although the cold is somewhat tempered there by a deep and reliable snow cover.

The two to four conspicuously ribbed (plicate) leaves are bold and attractive, attaining a length of ten inches or more. Unfortunately they are not reliably evergreen here; by winter's end they are limp and tattered. In the wild the seven to fifteen flowers are borne on a scape which can be nearly twenty inches tall. My plant, in its third season in cultivation, produced ten flowers on a scape about fifteen inches tall. But even a single flower would be enough to make the plant worth growing. The flowers themselves are beautifully formed and colored. They are about an inch-and-a-half broad. The sepals and upper petals are nearly alike in shape and color, widely spreading, and colored a

The delicate, almost spidery flowers of Calanthe discolor *var.* bicolor *f.* sieboldii. *Photograph by R. Weaver.*

soft yellow-green. The sharply contrasting deep red lip is broad and somewhat scoop-shaped with three longitudinal scalloped ridges (*tricarinata* means with three ridges or keels) on its upper surface. The spur is barely visible.

The flowers are produced with the new leaves in early to mid-May in my garden, about the same time that *Trillium grandiflorum* blooms. It has been vigorous in cultivation, although it has not increased after three seasons. I grow it in gravelly loam to which I have added a bit of peat moss. The site is on a gentle slope, insuring good drainage, shaded from the direct sun most of the day by the back of my garage. I feel that good drainage, especially during the winter, is one of the most important considerations for growing orchids outdoors (as well as indoors for that matter), as long as supplemental moisture can be supplied during periods of dry weather.

Calanthe discolor Lindley, the most easily available of the remaining hardy species, is a variable and widespread plant native to all four of the major Japanese islands as well as Korea and possibly also China. The two to three prominently plicate leaves, as much as ten inches long and three inches broad, are semi-evergreen as in the previous species. In the wild, the ten or so flowers are borne on a stalk which may reach twenty inches tall. Individually they are about an inch across with narrow greenish to purplish brown segments except for the prominent white to rose-colored lip.

Several natural color variations are perhaps more attractive than

variety *discolor,* the plant described above. Variety *bicolor* (Lindley) Makino (also known as *C. striata* R. Browne) has larger flowers with cinnamon-brown segments, while its forma *sieboldii* (Decaisne) Ohwi has uniformly clear yellow flowers. All of these intergrade in nature, producing an array of hybrids with pinkish, brownish, golden, and reportedly even red flowers. All bloom in the spring with the new growth.

I have not been as successful with this species as with *Calanthe tricarinata.* I have had a plant of (supposedly) variety *discolor* outside for five winters. It appears perfectly hardy and it has increased but never flowered. It is planted close by the plant of *C. tricarinata* described above, which should suit it since the two species grow in similar habitats in the wild.

Keisling (1981) reported success in growing *Calanthe discolor* var. *discolor, C. discolor* var. *bicolor,* and *C. discolor* var. *bicolor* f. *sieboldii,* as well as with *C. japonica* Blume. The last of these needs verification since the species is subtropical and is probably tender. However, at least two other Japanese calanthes should be hardy in New England. I have only recently acquired these, so their hardiness cannot be verified at this time, but short descriptions follow.

Calanthe reflexa Maximowicz would be a valuable addition to our garden flora if it indeed proves hardy and amenable to cultivation since it is one of the few showy orchid species which blooms in the late summer or early fall. The plant is similar in size and aspect to those species described previously, but the flowers are slightly smaller and more delicate. The segments are pale purple in color with the lip slightly darker. The specific name "*reflexa*" refers to the fact that the sepals are curved backward or reflexed and held together behind the lip; the very narrow lateral petals are more spreading.

The species is distributed through the southern three of the main Japanese islands as well as on the island of Cheju (Quelpaert) off the southern tip of the Korean Peninsula and in western China. Those plants from northern Honshu in Japan would probably be the best for cultivation in the northeastern United States.

Calanthe nipponica Makino is one of the rarer of the Japanese species. Since it is restricted to Hokkaido and central and northern Honshu, it should also be among the hardiest species in the genus. It is rather more delicate in appearance than the other calanthes discussed here. The leaves are relatively narrow, seldom more than an inch-and-a-half broad. The inflorescence may be nearly two feet tall, and the five to twelve flowers are widely spaced. The flowers are yellow, except for red markings on the lip, with narrow segments giving them a somewhat spidery appearance. They appear in the spring with the new growth.

All of the *Calanthe* species described above should respond well if cultivated in a semi-shaded position with well drained but never dry soil. Paschall, in Britain, recommends (1972) the addition of bone meal before active growth has begun. None of the species should be

The inflorescence of Cremastra variabilis. *Like many orchids, the flowers of this species do not open completely. Photograph by R. Weaver.*

crowded in the garden since all produce numerous, fleshy, brittle roots which may become six or more inches long. These should be allowed to spread unhampered. In the climate of Boston at least *C. discolor* and *C. tricarinata* appear to be hardy without protection, although in more severe climates a mulch of pine needles would probably be advantageous.

Cremastra

Plants of the genus *Cremastra* are among the least well known of the hardy Asiatic orchids, even though most of the five or so species have relatively large showy flowers. The genus is restricted in its distribution to temperate and subtropical Asia, from Sakhalin to the Himalayas, but it has a relative in our native flora. One of the species is commonly classified in *Aplectrum,* whose sole member otherwise is the American *A. hyemale,* the puttyroot or Adam-and-Eve orchid.

I have successfully grown *Cremastra variabilis* (Blume) Nakai for several years. This native of rich forests in Japan and Korea resembles the puttyroot in a number of characteristics: it grows from a colorless, fleshy, corm-like pseudobulb; the solitary plicate leaf is wintergreen and it disappears just before the flowers open to reappear in midsummer; it is a sporadic bloomer, only a few plants in a colony producing flowers in a given season. But the differences between *Cremastra variabilis* and *Aplectrum hyemale* are much more significant hor-

ticulturally than their similarities. The leaf of the *Cremastra* may be as long as fifteen inches, at least twice as long as that of the puttyroot. And the flowers are much finer. Appearing in early June, they are an inch to an inch-and-a-half long, with ten to twenty borne on a stalk about ten inches tall. The slender sepals and lateral petals are similar in shape, size, and coloration, and they spread only slightly. They are pale pink, dusted with fine purple dots near their tips. The lip is whitish, suffused with yellow.

Most of my plants were collected near Sapporo, Japan, and they have been perfectly hardy without protection through three winters. Several have increased, but only one has flowered. They are grown with most of my other Asiatic orchids in a light, humusy, slightly acid soil in partial shade.

Cymbidium

Several years ago (Weaver, 1977), I reported on the successful outdoor cultivation of *Cymbidium goeringii* (Reichenbach *f.*) Reichenbach *f.*, but additional information is now available and an update is in order. During the Arnold Arboretum's collecting trip to Japan later that same year I visited the city of Sendai, north of Tokyo on the east coast of the main island of Honshu. Although the latitude of Sendai is approximately 38°N., the climate is mild and the forests are the warm-temperate, broadleaved evergreen types found over much of southern and western Japan. From Sendai we traveled to the mountains inland where the climate is considerably cooler and the broadleaved evergreen trees essentially disappear. On drier slopes, where the canopy of the forest is relatively open, I was delighted to find *Cymbidium goeringii* as an important component of the herbaceous ground cover, along with other such familiar plants as *Epimedium grandiflorum* and *Lilium auratum*. I collected two plants and was able to bring them home in good condition.

Cymbidium goeringii is native to China and Korea as well as to Japan. In the latter country, Sendai is near the northern limit of its natural range, and plants collected there should be among the hardiest of their species. The plant on which I reported earlier was purchased, and its provenance is not known. It survived the winter of 1976–1977 outdoors in my garden, but it died during the more open winter that followed, even with a heavy mulch. One Sendai plant (the other was kept indoors as a safeguard) however survived the winter of 1977–1978 in good condition, as it has every one since with only a minimum of mulch. After this past severe winter I feel that I can safely add *C. goeringii* to our hardy garden flora.

As cymbidiums go, *Cymbidium goeringii* (incorrect synonyms are *C. virescens* and *C. virens*) is not a spectacular plant, and it has never been popular in western horticulture, even as a greenhouse plant. In contrast, it has been for centuries part of the traditional horticulture of

Cymbidium goeringii *has long been used as a decorative motif in Japan and China. It is seen here on a piece of modern Japanese china. Photograph by R. Weaver.*

both China and Japan. It is valued for the rhythmical form of its graceful foliage and delicate flowers, and it is understandably a favorite subject of painters. But mostly it is revered for its fragrance, which has been called according to Li (1959) "the scent of the kings." Natural variants, which include plants with variegated leaves, red flowers (reportedly), and a two-flowered scape are particularly sought after and occasionally are sold for the equivalent of thousands of dollars.

Unlike most of its genus, *Cymbidium goeringii* grows terrestrially rather than epiphytically. The small, nearly buried pseudobulbs persist for several years and produce a mass of thick fleshy roots. The narrow, almost grasslike leaves vary from eight to twelve inches in length and are evergreen, although they may brown at the tips in severe winters. The solitary flower appears on a fleshy stalk from the base of the pseudobulbs in the spring. The two-inch flowers are basically green except for the lip which is white spotted variously with red.

My plant has annually produced vigorous shoots and has doubled in size, but it has not flowered. Perhaps our winters are too severe for the flower buds, but perhaps I have not given it quite the proper conditions for blooming. I grow it under conditions similar to those in its natural habitat — a well-drained but not dry slope with humusy soil and partial shade but with annual springtime fertilization — and I will continue to be patient. I hope eventually to be rewarded with flowers, but merely being able to grow a cymbidium outside is sufficient reason for keeping it.

Cypripedium

The genus *Cypripedium,* the lady's-slippers, consist of about forty species almost continuously distributed across the North Temperate Zone, with one species, *C. irapeanum* Lexarza extending into the American tropics. Although the species vary greatly in their ease of culture, some, particularly the American varieties of *C. calceolus* Linnaeus, the yellow ladyslippers, are the most satisfactory orchids for the wildflower garden.

The majority of *Cypripedium* species are native to Asia, from Japan to the Himalayas. Although many have been in cultivation at some time or another, most have been lost subsequently; the only one at all commonly cultivated at present is the widespread Eurasian *C. macranthum* Swartz. The wonderful Chinese species are still unavailable, but several of the five or so Japanese lady's-slippers can be imported nearly as cheaply as our native ones can be purchased domestically. All lady's-slippers are particularly susceptible to rot; soaking the plants in a fungicide immediately upon receipt is imperative, even if they are completely dormant.

The two species discussed below are among the most distinctive in the genus, and both have reputations for being difficult to cultivate. I feel that this reputation is unfounded, as long as plants can be obtained in good condition in the first place. *Cypripedium debile* Reichenbach *f.* has no English common name. It is among the most diminuitive of lady's-slippers, and to the uninitiated eye might not be recognized as a member of this generally showy group of plants. It is a plant of mountain forests throughout Japan except for the mostly subtropical island of Kyushu and it has been collected a few times in the western Chinese province of Szechuan.

The plants grow from slender creeping rhizomes by which they form small colonies in the wild. Except for that of a closely related but even rarer Himalayan species, the foliage is unique in the genus. There are always two leaves, borne opposite each other atop a stem which reportedly grows to six inches tall but which has never been taller than two inches in my plants. The leaves themselves are broadly ovate, from one to two inches across, completely hairless and lustrous. Three to five prominent veins run their length and converge at the tips. The flower stalk arises from between the leaves, but as the single buds mature, the stalk elongates and turns downward. When the flower opens in early to mid-June, it is borne upside down, below the leaves. In my plants it nearly touches the ground.

The flower itself is delicately beautiful, even though it is difficult to admire because of its hidden position. The dorsal sepal, the synsepal (the united ventral sepals) and the lateral petals are nearly alike in size and shape, and they are all pale green with darker lines or blotches at their bases. The lip, about the size of a large pea, is pale pink with a ring of purple lines around the mouth. The whole flower is

Above: A plant of Cypripedium debile *showing the inverted position of the fully open flower. Below: Closeup of the flower of* Cypripedium debile, *held above the leaves for a better view. Photographs by R. Weaver.*

The striking flower of Cypripedium japonicum. *Note its resemblance to the flower of our native pink lady's-slipper* (C. acaule). *Photograph by R. Weaver.*

little more than a half inch across. What it lacks in size it certainly makes up in lasting power. An individual flower may remain in good condition for nearly a month, longer than that of any other hardy orchid.

My oldest plant has survived and flowered after three winters without protection except for a standard inch-thick mulch of pine needles. It is planted in deciduous shade in a light, humusy, slightly acid soil. The only special care I provide is to remove scrupulously any plant which might compete too closely with it.

While most visitors to my garden pass *Cypripedium debile* without notice, few miss *C. japonicum* even when it is not in flower. The pair of fan-shaped, corrugated leaves are texturally incomparable in a New England garden and would alone make the plant well worth growing. With its wonderful flowers in addition, the Japanese lady's-slipper is surely one of the aristocrats among hardy plants.

Cypripedium japonicum Thunberg is widely distributed in Japan, occurring on all of the major islands. It was also widespread in the upper Yangtze Valley in western China. A closely related species, *C. formosanum* Hayata, inhabits the island of Taiwan. I have not observed the plant in the wild, but it is apparently still quite common in forests and bamboo thickets at low elevations in Japan. According to Summerhayes (1938) it at least formerly occurred in countless thousands in certain districts of China, where its local name means "Devil's Umbrella."

Unlike most of our native lady's-slippers, which have a cluster of

thick roots spreading from a congested rhizome, *Cypripedium japonicum* grows from a slender, elongate rhizome with clusters of rather delicate roots from the nodes. The wonderful leaves are borne in a nearly opposite pair at the apex of a hairy, eight to fifteen inch stem. They open like two fans, densely crinkled at first, becoming six to ten inches broad and nearly flat at maturity but with numerous conspicuous veins radiating from the base toward their margin like spokes.

The solitary flower appears in mid- to late May, arising on a slender stalk from between the leaves. The dorsal sepal and the lateral petals are rather alike in size and appearance — untwisted, slender-pointed and yellowish green with red spots at their bases. The egg-shaped lip is whitish marbled with pink; it is variously spotted with red, particularly at the base and within the orifice. The flower evokes widely differing responses from different observers. Many would call it serene or beautiful. Elick (1975) describes it as "bloated and obscene." At any rate it is certainly striking and unusual. Though less refined, it is somewhat reminiscent of that of our native pink lady's-slipper (*Cypripedium acaule* Aiton) in size and configuration, with the orifice of its pendent lip directed outward and downward (in most other lady's-slippers the lip is more nearly horizontal with the orifice directed upward).

Once *Cypripedium japonicum* is established, it appears to prosper in cultivation. I started with a small plant imported from England in 1974. It moved with me the following year, and it has increased ever since; there are four shoots this season. Unfortunately it seems to flower in alternate years. The present site is rather densely shaded — at the base of an azalea under an apple tree — with a light, humusy soil; a previous site, under hemlocks, proved to be too dry. It apparently does not resent root competition from other plants, either in the wild or in cultivation. Although I mulched it heavily the first few winters, it no longer receives special protection in my garden and appears to be perfectly hardy.

Epipactis

Plants of the genus *Epipactis,* commonly known as helleborines, are widely distributed across the Northern Hemisphere. They are confused taxonomically, and the number of species recognized varies considerably from author to author. Most of them are European, and one of these, *E. helleborine* (Linnaeus) Crantz, has become naturalized in the eastern United States. The only native American species is *E. gigantea* Douglas *ex* Hooker, known as chatterbox because of the mobile lower portion of its lip, a familiar orchid along streams in the western mountains.

Only a few species of *Epipactis* are native to eastern Asia. One of these, a wide-ranging plant in Japan, Korea, and eastern China, has been considered a variety of our *E. gigantea.* It is really a quite

Although their color is different, the shape of the flowers of Epipactis thunbergii *is reminiscent of those of* E. helleborine, *a European species which has become widely naturalized in the eastern United States. Photographed by R. Weaver.*

different plant and is now generally recognized as a separate species *E. thunbergii* A. Gray. I have found this species to be an easy and satisfactory plant. It blooms in early to mid-July, a time when orchid flowers are scarce in the garden. The creeping rhizome gives rise to tall, erect stems which bear prominently veined, lanceolate leaves with clasping bases at regular intervals. The inflorescence is terminal on the stem, and the ten to twenty flowers, each subtended by a leafy bract, open in succession. As they open, they bend in such a way as to make the inflorescence appear one-sided. The flowers are about three-quarters of an inch across and are somewhat variable in color. On my plant the sepals and lateral petals are bright golden yellow, beautifully setting off the lip with its bright rose-purple mid-lobe. Although the plants may be as tall as thirty inches in flower, they are not coarse.

Epipactis thunbergii is a bog plant as are many of its relatives. Since the plants are so susceptible to rot, a general rule in growing orchids both indoors and in the garden is this: if in doubt, grow them on the dry side rather than on the wet side. Heeding this, I punched large holes in the plastic lining of my artificial bog, and my bog orchids started growing rather than rotting. Actually, *Epipactis thunbergii* would probably respond well if planted in a normal woodland type soil, as long as it is well watered. It also should have full sun for at least four hours a day.

Liparis

Liparis is a moderate sized genus with representatives in the temperate and tropical zones of both hemispheres. The tropical species are diverse, and many grow epiphytically, but the temperate terrestrial species are mostly similar in general appearance. They have two equal, hairless, basal leaves with narrowed, sheathing bases from within which grows the slender-stalked, many-flowered inflorescence. They grow from pseudobulbs which are typically just below the surface of the soil. The temperate species are commonly known as twayblades, because of the two leaves.

Two species of *Liparis* are native to the northeastern United States, and both of them have very similar Asiatic relatives. The lily-leaved twayblade (*L. lilifolia* L. C. Richard), is a widespread and familiar, but seldom abundant, native orchid in deciduous woodlands throughout most of the northern quarter of our country. Its oriental counterpart, from Japan, Korea, and Soviet Eastern Asia was long considered to represent the same species, but is now generally recognized as the distinct *L. makinoana* Schlechter. The oriental species has flowers nearly twice the size of those of *L. lilifolia,* but they look much alike otherwise and they have similar cultural requirements.

Although its flowers are relatively large and attractively shaped, they are not brightly colored, and *Liparis makinoana* is not a conspicuous plant in the garden. Nevertheless it is probably the showiest of the hardy *Liparis* species and well worthy of cultivation. A vigorous specimen may stand a foot tall, with fifteen or more flowers loosely arranged on an erect inflorescence. The flat, translucent, purplish brown, conspicuously veined lip is by far the most conspicuous part of the flower, particularly since the lateral sepals and threadlike petals are nearly hidden behind it. It varies in length from a half- to three-quarters of an inch, and nearly so in width. The flowers open in late May in my garden and continue until mid-June.

Liparis makinoana is very rare in cultivation in the United States, but it is occasionally grown in the British Isles, primarily as a pot plant. My original plant was purchased, so I know nothing of its provenance. But plants from throughout its natural range should be hardy in much of the eastern United States. My plant has survived four winters outdoors without protection, and has increased nicely.

Loesel's twayblade, or the fen orchid (*Liparis loeselii* (Linnaeus) L. C. Richard), is a plant of bogs and seepages of the northern United States. A similar species, but a woodland plant instead, *L. kumokiri* F. Maekawa, is widespread in Japan and Korea. It is similar in stature to *L. makinoana,* but the flowers are smaller, more densely arranged, solid yellow-green in color including the lip and they appear about two weeks later. The lip is also smaller in relation to the flower overall, and it is abruptly bent downward at about the middle. My plants were collected on the Japanese island of Hokkaido in the fall of 1977, and

Left: A plant of Liparis makinoana, *showing the two basal leaves which give the genus its common name of twayblade. The prominent, veined lip is the most conspicuous part of the flower. Right: The charming and delicate flowers of* Liparis kumokiri. *Photographs by R. Weaver.*

they appear to be perfectly hardy without protection in the garden. The species is practically unknown in western gardens.

Although *Liparis* species are generally not showy, plant and flower form is delicate and refined, and all of the hardy species are worthy of cultivation. At least four other Japanese species, *L. nervosa* (Thunberg) Lindley, *L. auriculata* Blume, *L. krameri* Franchet & Savatier, and *L. japonica* (Miquel) Maximowicz, should be hardy in the northeastern United States, and Keisling has reported success with the Taiwanese *L. sasakii*. The species I have tried are undemanding and vigorous in the garden; they appear to be among the easiest hardy orchids to cultivate. General wildflower garden conditions — deciduous shade, with a light but humusy, slightly acid soil — suit them well. They are extremely easy to transplant since the pseudobulbs are essentially rootless from October through May. Unfortunately their lack of roots, in addition to their shallowness in the soil, render the bare pseudobulbs extremely susceptible to frost-heaving in the winter as well as unearthing by squirrels or other rodents. Therefore they should be carefully protected with a good mulch as well as a small sheet of chicken wire.

Spiranthes

The genus *Spiranthes* includes a number of native orchids commonly known as lady's-tresses because the spirally twisted inflores-

The spirally twisted inflorescences of Spiranthes sinensis. *The lower flowers have already gone by and the capsules are beginning to develop. Photograph by R. Weaver.*

cences bear resemblance to braided locks of hair. Of these *Spiranthes cernua* (Linnaeus) L. C. Richard, the nodding lady's-tresses, is one of the commonest and most familiar orchids of the northeastern United States. Another species, *Spiranthes sinensis* (Pers.) Ames is one of the commonest terrestrial orchids of eastern Asia, ranging widely from Sakhalin to Malaysia and Australia.

The hardy Spiranthes species generally are not showy plants, and *S. sinensis* is no exception. But it is distinctly charming and worthy of cultivation. The plants grow from a cluster of short, fleshy, tuberlike roots, and the narrow, wintergreen leaves are mostly clustered into a loose rosette at the base of the stem. These wither after flowering to reappear in the late summer. The habit is rather similar overall to that of the American *S. lacera* (Rafinesque) Rafinesque.

The spikes are evident by mid-June and they are fully open by late in that month or in early July. They are from two to six inches long, densely many-flowered, on a stalk which may reach fifteen inches in height. The pale rose flowers, in contrast to the white ones of most American species, are about a quarter of an inch long, and close inspection is necessary before their exquisite form can be fully appreciated.

In the wild *Spiranthes sinensis* normally grows on grassy slopes, roadside banks, or other sunny places and at times could almost be called weedy. It appears to be extremely amenable to cultivation,

increasing nicely in a well drained position with sun most of the afternoon. Because of its delicate stature and cultural requirements it is one of the few orchids perfectly well suited for growing in a rock garden. Wherever it is grown it must be carefully sited to avoid its getting lost, because when not in bloom the plant is extremely inconspicuous. And because of its wide natural range, plants for cultivation in the northeastern United States should be carefully selected to ensure a hardy stock. Most Japanese and Korean material, however, should be reasonably hardy.

This is only a small sampling of the exotic orchids which should be amenable to cultivation in the eastern United States. I will be trying more in the future. I hope that this article will stimulate readers to try several species themselves, and I would appreciate reports on any experience with these or other species, particularly as concerns their hardiness.

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Appendix

Following is the address for obtaining a plant importation permit:

Permit Unit
USDA, APHIS, PPQ
6505 Belcrest Road
Federal Building
Hyattsville, Maryland 20782

Following are nursery sources for the plants treated in this article:

Alpenglow Gardens
13328 King George Highway
Surrey, British Columbia

Avon Bulbs
Bathford
Bath BA1 8ED
Great Britain

Chow Cheng Orchids
194 Litoh Street
Taichung, Taiwan

Orchids, Ltd.
407 East Carson Avenue
Carson, California 90745

Santa Barbara Orchid Estate
1250 Orchid Drive
Santa Barbara, California
93111

Siskiyou Rare Plant Nursery
522 Franquette Street
Medford, Oregon 97501

Tatsuo Niizuma
6–10, Yamate-2-chome
Nakasuji, Takarazuka
Hyogo 665, Japan

The Ginkgo in America

by PETER DEL TREDICI

During the eighteenth and nineteenth centuries, private estates played a central role in the development of American horticulture. Wealthy landowners enthusiastically planted everything they could get a hold of in a spirit of experimentation. Most of these gardens are now either badly overgrown or totally destroyed. The few that remain are fully mature and give little indication of the reckless abandon with which they were originally planted.

Wodenethe, Henry Winthrop Sargent's estate in Beacon, New York, is a good example of this horticultural experimentation. Between 1840 and 1882, Sargent planted hundreds of exotic species, many of which had never been grown in this country (Sargent, 1897b). When I visited Wodenethe in the spring of 1981, very little trace of Mr. Sargent's work could be found. The main building had been razed and a housing development built on the estate. But here and there a few relics of the glorious past remained. In all, I found about twenty trees that could be traced back to Sargent's day. A beautiful old ginkgo in particular caught my eye. I felt, somehow, that I had seen this tree before. And indeed, I had, in other nineteenth century estates I had visited, where old ginkgoes had similarly survived the twin test of time and neglect.

No one appreciated the powers of endurance of *Ginkgo biloba* better than Professor C. S. Sargent, Henry Winthrop's cousin, who, writ-

Figure 1. *The ginkgo planted by Henry W. Sargent at his estate, Wodenethe, at Beacon, New York. Photograph by P. Del Tredeci.*

ing about Wodenethe in 1897, made a prediction: "A ginkgo just beginning to emerge from its juvenile form promises to become a long lived and large tree." Not only has Sargent's prophesy come true, as can be seen from Figure 1, but the ginkgo he planted on his own estate in Brookline, Massachusetts, has also grown into a large and beautiful tree.

The survival power of the ginkgo is legendary in China, Japan and Korea, where there are many trees that are close to 1000 years old (Figure 2). One tree in Korea, reputed to be the largest in Asia, is said to be 1100 years old (Figure 3; Spongberg, 1978). It is remarkable enough for a wild tree to live this long, to say nothing of a cultivated tree. Whether the ginkgo still exists in the wild is a matter of controversy. E. H. Wilson always denied the existence of any wild ginkgoes (1916, 1919), but Li (1956) presents convincing evidence that wild trees were extant in eastern China as late as 1933. Whether these trees still exist is not known.

The ginkgo is remarkable not only for its survival through historic time, but also for its persistence through geologic time. The order to which the tree belongs, the *Ginkgoales,* can be traced back to the Permian era, almost 250 million years ago (Tralau, 1968). This is sufficiently long ago to make the *Ginkgoales* the most ancient living order of the class Gymnospermae. The genus *Ginkgo* made its first appearance in the lower Jurassic period, 180 million years ago. According to Hans Tralau, the foremost authority on fossil ginkgoes, at least four different species of Ginkgo coexisted with the dinosaurs during the Lower Cretaceous. One of these, *G. adiantoides,* possessed leaves which are considered identical to those of *G. biloba,* the species that exists today. Showing the caution characteristic of a good scientist, Tralau concludes ". . . that it might be reasonable to expect the direct predecessors of Tertiary and Recent *Ginkgo* in this part of the Lower Cretaceous population of *Ginkgo.*" This direct link with ancient fossil plants gives the modern *Ginkgo biloba* a pedigree unmatched by any living tree, and is the basis of the oft repeated claim that the ginkgo has existed on earth longer than any other tree (Major, 1967).

More than one researcher has suggested that part of the explanation for the ginkgo's longevity is due to the tree's near immunity to insect damage and fungal diseases (Major, 1967). While there may be no correlation between immunity to modern pests and immunity to Cretaceous pests, the fact that pathologists consider the ginkgo ". . . less susceptible to disease, in general, than any tree grown in the United States" (Hepting, 1971), suggests that disease resistance may partly explain the ginkgo's remarkable tenacity.

Ginkgo biloba was introduced into Europe from Japan at the Botanic Garden in Utrect, Holland about 1730, where, according to Dallimore and Jackson, ". . . a tree which may be one of the original introductions is still in very good condition (1964)." The ginkgo did not officially reach North America until 1784. According to Andrew

Figure 2. *The ginkgo at Zanpukuji Temple, Tokyo, Japan. In 1914, the diameter of the tree was 9 feet and 6 inches and its height was 50 feet. The tree was approximately 700 years old. Arrow indicates the stalactite-like burls, known as "chichi" (nipples) by the Japanese. These are leafless, positively geotropic spur shoots that take root when they reach the ground and form new shoots (Fujii, 1895). Photograph by E. H. Wilson.*

Figure 3. *The ginkgo on the temple ground at Yongmun-san, Korea. The tree is about 200 feet high and about 15 feet in diameter. It is reputed to be 1100 years old. The utility pole near the base of the tree offers some scale. Photograph by R. E. Weaver, Jr.*

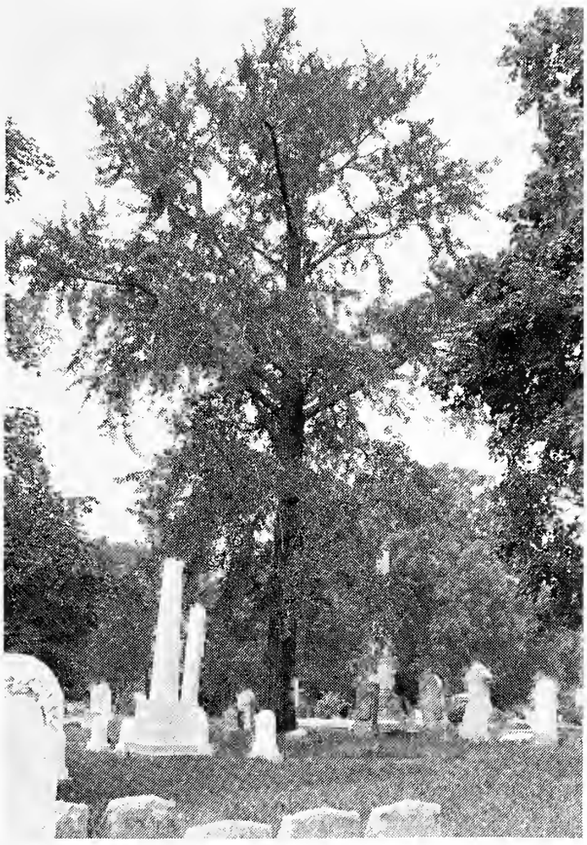

Figure 4 (left). *The male ginkgo tree in Woodlands Cemetery, Philadelphia planted in 1784 by William Hamilton. This tree, and the female shown in Figure 5, are the oldest ginkgoes in the United States. This is the same tree illustrated by Wilson (1919) and Rehder (1936). Today the tree is 68 feet tall and 30 inches in diameter.* Figure 5 (right). *The female tree at Woodlands Cemetery, Philadelphia, planted in 1784 by William Hamilton. It is 60 feet tall and 32 inches in diameter. The main axis has suffered considerable damage. Photographs by C. Hipple.*

Jackson Downing, writing in 1841, the first trees in America were planted in Philadelphia by William Hamilton on his estate "The Woodlands." Two of these original plants, a male and a female[1] still survive (Figures 4, 5). These trees, while not the most beautiful specimen ginkgoes, are the oldest plants in the country (Wilson, 1919; Rehder, 1936). Another ginkgo tree in John Bartram's garden in Philadelphia, thought to be the same age as Hamilton's trees (Wilson, 1919), is bigger than both of them and in better condition.

Downing mentions another ginkgo, ". . . standing on the north side of that fine public square, the Boston Common. It originally grew in the grounds of Gardiner Green, Esq., of Boston, but though of fine size, it was, about three years since, carefully removed to its present site, which proves its capability for bearing transplanting. Its measurement is forty feet in elevation and three in circumference." If the tree was that large three years after it was moved, it must have been nearly that large at the time of moving (Figure 6). Although this tree was standing in 1951 (Ley, 1951), it is no longer there. Unfortunately, I have not been able to learn why or when it was removed.

[1] The terms male and female are commonly used in reference to ginkgoes and other plants. While this usage is widely accepted, it is, unfortunately, botanically incorrect. To be accurate, ginkgoes should be called either microsporangiate or ovulate.

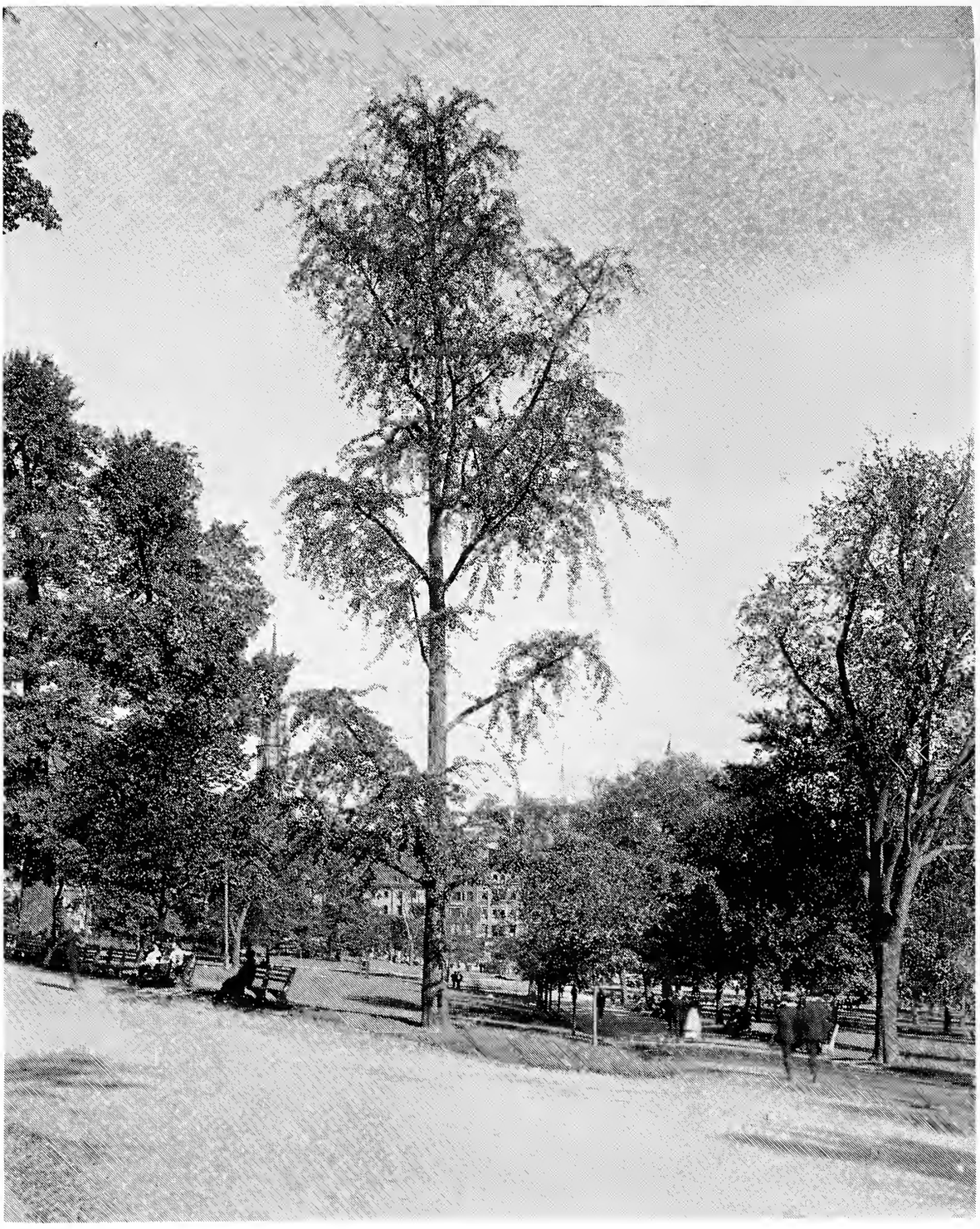

Figure 6. *The ginkgo on the Boston Common, photographed in 1919 by A. A. Greenlaw. The tree was moved to the Common in 1838 when it was 40 feet tall and one foot in diameter. In 1925 it was 55 feet tall.*

On the site of the old Harvard Botanical Garden in Cambridge, Massachusetts (now graduate student housing), a beautiful female tree, dating back at least to the days of Asa Gray, still flourishes (Figure 7). As in the other gardens I visited, it is one of the few original trees left. Large ginkgoes, of comparable size, are scattered up and down the east coast between Washington and Boston. Philadelphia seems to be particularly rich in old ginkgoes (Moore, 1943).

An isolated group of old ginkgoes once existed in Kentucky. Claxton (1940) maintains that these ginkgoes arrived at Washington, D.C. as seedlings from Japan and were subsequently sent to Kentucky by Henry Clay. As far as I have been able to determine at least two of

Figure 7. *A female ginkgo in the old Harvard Botanical Garden, Cambridge, Mass. While its exact age is unknown, a photo from 1888 shows the tree to be almost as tall and to have the same branching pattern that it does now. Today the tree is 63 feet tall and 38 inches in diameter. Note the buttressed base of the tree. Photograph by P. Del Tredici.*

these trees, a fertile male and female pair, still exist in Frankfort, on the grounds of the former Kentucky Military Institute.[2] Both trees are in rather poor condition, with the larger one measuring 27 inches in diameter. The fact that the Institute was started in the 1850's suggests that the trees were probably planted around that time. Dr. John Stewart, whose family has owned the Institute since the time of its closing in the 1890's, repeated Claxton's story that the trees came from Henry Clay and added the note that they were the first ginkgoes to be planted in Kentucky. The historical significance of these trees does not stop here, however, for Ward, writing in 1885,[3] and Sargent, in 1890, both indicate that the female of this pair was the first ginkgo in the United States reported to bear seeds. In 1890, Mr. W. R. Smith, the curator of the U. S. Botanical Gardens in Washington (Falconer, 1890) had this to say about the tree: "The female produces a large quantity of seed every year, and has been up to date our chief source of supply." Although none of these authors say when this "fruiting" first occurred, a minimum date can be established by the fact that the Arnold Arboretum received an accession of ginkgo seeds from the "Military Institute, Kentucky" on January 7, 1878. Unfortunately,

[2] The Institute is now the Stewart Home School.

[3] The statement by Ward that the first tree in the country to bear seeds was on ". . . the grounds adjacent to the University of Kentucky at Frankfort . . . " is clearly in error, given that there never was a branch of the University of Kentucky in Frankfort. Undoubtedly he was referring to the Military Institute tree.

Figure 8. *A young ginkgo tree showing the whorled, conifer-like branching habit. The angularity of the young trees harmonizes well with the sharp, straight lines of the city. Photograph by P. Del Tredici.*

none of the trees from this seed collection, if there were any, have survived.

Stunning as mature specimen ginkgoes are, they contrast strikingly with young trees, which have an awkward appearance (Figure 8). C. S. Sargent, writing in 1897, summed up the contrast between young and old trees.

> "Stiff and almost grotesque in its early years, with slender, remote, wide-spreading branches and sparse foliage, the Ginkgo does not assume its real character until it is more than a century old. There are few trees whose youth gives so little indication of future splendor; and so little picturesque is the Ginkgo in early life, and so badly does it blend with American surroundings that a great landscape gardener, knowing only young trees, declared that it could have no place in our landscape planting. If, on a bright November day, he had seen the great trees in Kamakura, or in the gardens of Asakura, in Tōkyō, he would certainly have recognized the great possibilities of the Ginkgo for picturesque planting. In the United States the Ginkgo is perfectly hardy as far north as Massachusetts, and thrives as well in the south as it does in the north. There are not, however, any very large or fine specimens in this country, although the tree planted nearly a century ago in the gar-

> den at Hyde Park, on the Hudson River, has begun to assume mature habit and shows that later generations may hope to see eastern America rival eastern Asia in its Ginkgo trees."

Once again, C. S. Sargent has proved himself to be a great prophet. This Hyde Park tree, planted by Dr. David Hosack, the founder of the Elgin Botanic Garden[4] is still standing, an inspiration to a new generation of tree planters and a tribute to the foresight of a past generation of experimenters. This is certainly the most beautiful ginkgo in North America, and also the largest I could locate (Figure 9).

The lesson in all of this is, of course, that C. S. Sargent was right. The ginkgo does grow as well in North America as it does in Asia. When planted as a specimen, unshaded by other trees, it can be counted on to live at least a hundred years and probably two hundred. It is truly remarkable that the ginkgoes which were impressive when Downing and Sargent were writing are still alive today. In eastern North America, there is no other exotic tree except perhaps the European beech, that can endure as long as the ginkgo. To quote C. S. Sargent once again, ". . . if a man wants to plant for posterity, for it must not be forgotten that it has taken from five hundred to one thousand years to build up the great ginkgoes of Japanese and Chinese temple gardens, he is reasonably safe in selecting this tree for his purpose." Indeed, William Hamilton and David Hosack will not soon be forgotten, thanks to the trees they left behind.

Acknowledgements

Many people have cooperated with me in this study. In particular, Prof. Elso Barghoorn of Harvard University; Mrs. Barry Bingham of Louisville, Kentucky; Mr. R. Earl Hood of Woodlands Cemetery, Philadelphia; Mr. W. F. Hubbard of the National Park Service; and Mr. Paul Meyer of the Morris Arboretum, Philadelphia. Michael Koralewski of the Arnold Arboretum was kind enough to measure the ginkgoes in Woodlands Cemetery for me.

Addendum:

After this article was in page proofs, the author discovered the following quotation from 1877 by C.S. Sargent (*Gardner's Monthly* 19:358): "One of the Salisburias, planted some twenty years ago in the grounds of the Kentucky Military Institute at Farmdale, Ky., and now thirty feet high, proves to be a female, and has fruited this year for the first time. I am not aware that this interesting tree has fruited before in the United States, while in Europe specimens known to be female are still very rare. Through the kindness of Prof. R.H. Wildberger,

[4] This garden, once part of Columbia University School of Medicine in New York City, is considered to be the first "actual" Botanic Garden in the United States (Rehder, 1936).

Figure 9. *Dr. Hosack's ginkgo at Hyde Park, New York, now part of the Roosevelt-Vanderbilt National Historic Sites. Just below the lowest branch, the diameter of the tree is 5 feet 5 inches. The tree is about 85 feet tall. This is the largest ginkgo that I was able to locate in North America. Note the abrupt taper of the main axis, suggestive of both* Metasequoia *and* Pseudolarix. *Photograph courtesy of the National Park Service.*

specimens of the ripe fruit are before me. Its fleshy outer covering exhales an extremely disagreeable smell of rancid butter, but the kernel is excellent with the flavor of Filberts, although more delicate. In Japan the kernels have reputed digestive qualities, and are very generally served at dessert. The cultivation of the 'Ginjko' for its fruit is one of the possibilities of American Horticulture, and is, perhaps, worth consideration."

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Prunus × *yedoensis* 'Daybreak'

There are many different varieties and cultivars of flowering cherry trees available for use in today's landscape plantings. One of the more spectacular but little used cherries is a cultivar of *Prunus* × *yedoensis* known as 'Daybreak'. The Japanese name 'Akebono' refers to two different cultivars one with single flowers, and the other with double ones. This article will concern the single-flowered cultivar and will use the name 'Daybreak'. *Prunus* 'Daybreak' is distinguished from other flowering cherries by abundant pink flowers that appear early in April, by its spreading habit, and by its glossy, lenticelled bark.

As a cultivar of *Prunus* × *yedoensis,* 'Daybreak' shares in a fascinating history. In *The Cherries of Japan* (1916), the famous plant explorer E. H. Wilson stated that the oldest known specimens of *Prunus* × *yedoensis* were growing in the Imperial Botanic Garden at Koishikawa, Japan; at that time the trees were approximately 40 years old. It was from this group of trees that the Japanese botanist Matsumura (1901) had first named and described *Prunus* × *yedoensis,* now thought to be a hybrid between the double white-flowered P. *speciosa* and the single pink-flowered P. *subhirtella* 'Rosea'. The common name, Yoshino cherry, comes from the name of the Japanese region known for its wild cherries.

In 1902 seeds were sent from Tokyo to the Arnold Arboretum, constituting the first known introduction of *Prunus* × *yedoensis* into the United States. Wilson commented that in 1916 there were over 50,000 Yoshino cherry trees growing in Tokyo alone. In the United States, perhaps the most famous collection of flowering cherry trees is

in the Tidal Basin area in Washington, D.C., where each spring a cherry blossom festival is held. These trees were a gift from the Mayor of Tokyo in 1912. Originally, there were 4,000 trees planted, 800 of which were Yoshino cherries. Today, many of them are dying of old age and less that 25 percent of the original trees remain standing.

The 'Daybreak' cultivar of the Yoshino cherry originated in 1920 from a tree in the collection of W. B. Clarke in San José, California. This tree, which had masses of flowers pinker than those of the species, was named and introduced into cultivation in 1925. The Arnold Arboretum has a single specimen of *Prunus* 'Daybreak' on its Jamaica Plain grounds; a plant was received from Mr. Clarke in 1949 and given the accession number 212-49. It can be found on the left side of the road leading to the top of Bussey Hill, where it appears to survive Boston's winters quite well. It is a wide-spreading tree with four main branches and has reached a height of 25 feet with an equivalent spread. A strong grower, it has many open spaces between its branches, giving it an "airy" silhouette. A graceful touch is added by the slightly pendulous nature of its outermost branchlets.

Prunus 'Daybreak' is one of the earliest of the flowering cherries to bloom. In Jamaica Plain the peak bloom period occurs in early to mid-April and lasts for two weeks. The pleasingly almond-scented blossoms are usually borne on leafless branches in clusters of two to six. Each flower consists of five sepals, five or six petals, numerous stamens, and one pistil. The petals are half an inch in diameter, and each has a slight notch on its outer edge. The 'Daybreak' cultivar is best known for the color of the petals, light pink, with the outline of each petal tinged slightly darker. The calyx and upper side of the flower pedicel are rose colored. It is interesting to note that when the petals drop in late April, the appearance of the tree turns from light pink to dark rose due to the conspicuous calyces.

The leaves of *Prunus* 'Daybreak' are ovate, four to five inches long, and two inches wide. The leaf margins are doubly serrate, with the very tips of the teeth pointing upward. The newly unfolded leaves are bright green, but by summer the upper surfaces are a leathery dark green and the lower surfaces light green. The leaf petioles are red above and green below; they have two or three characteristic reddish glands just below the base of the blade and are grooved from this point to the stem. In the fall the leaf color ranges from reddish bronze, to bright yellow, to bright red.

New stem growth is red above and green below, with the tiny lenticels appearing as red dots widely spread around the entire stem. In one year's time the stems become glaucous chestnut-brown above and light tan below. After two years, the bark becomes glossy brownish red, with the prominent horizontal lenticels exposing the rust-colored inner bark. This mature bark provides for year-round interest; it is especially striking when seen against the white of the winter landscape.

Because *Prunus* 'Daybreak' is a hybrid, and also because it depends on insects and weather for pollination, fruit-set is not entirely predictable. There was no fruit formed this past spring on the Arnold

The graceful, spreading habit and spectacular floral display of the 'Daybreak' cherry are evident in this specimen, located on Bussey Hill.

Arboretum specimen, but when fruit-set does occur it results in many small (½" diameter) drupes that ripen to a black color in late summer. These fruits are visually attractive both to man and to the many birds that seem to like their bitter taste.

Asexual propagation, by either budding or stem cuttings, is the best way to retain the desirable characteristics of this cultivar. Budding is best done in mid-summer and involves inserting several buds of *Prunus* × *yedoensis* 'Daybreak' into an appropriate rootstock such as P. *avium*. If stem cuttings are used, they should be taken from the spring softwood, dipped in a liquid hormone solution containing 8,000 ppm. IBA(indolebutyric acid) for five seconds, and then placed in a medium of equal parts peat and perlite. If the cuttings are kept in a high-humidity atmosphere (using mist or by enclosing them within a large plastic bag), rooting should occur within eight to ten weeks.

As of September 1980, *Prunus* 'Daybreak' was commercially unavailable in North America. Interested individuals and nursery businesses wanting to try this cherry tree may be able to obtain budwood from the Arnold Arboretum during the month of July, 1982. Requests concerning availability and service charges should be sent to the Arnold Arboretum well in advance and rootstock of *Prunus avium* should be prepared for budding.

In the cultivation of *Prunus* 'Daybreak' for home landscapes, there are very few problems that can not be solved. Care should be taken to select a suitable site where the soil is well drained, where the pH is in the range of 5.5 to 7.0, and where there is full sun for optimum flowering. During the spring of 1980, the specimen at the Arnold Arboretum sustained a moderate amount of leaf damage known as "shot-holing." As the name implies, the disease causes the leaves to look as if they have had shot fired through them, and may be caused

either by insects or a fungus. When no insects were found in a careful examination of the Arnold Arboretum specimen, it was hypothesized that a fungus was the cause. In a home landscape this damage would be discovered quite early, and the tree could be sprayed; in a larger area, such as an arboretum, the damage might not be discovered quite as early, and it might not be feasible to spray a single tree. However, the extra effort perhaps necessary to keep the tree vigorous, well pruned, and pest-free is worthwhile in the long run.

Prunus 'Daybreak' would be best used in landscaping as a specimen plant, in a location where the full splendor of the tree could be viewed from several different angles. The delightful pink floral display, the graceful spreading habit, and the glossy, lenticelled bark give this cultivar a potential to be used a great deal more in today's landscape.

Acknowledgments

Special thanks go to Gary Koller, supervisor of the living collections at the Arnold Arboretum, for his support and guidance with this project.

GREGORY J. WATERS

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Back cover: Closeup of the flowers of Calanthe tricarinata, *showing the beautiful form of the flowers and their prominently ridged lips in different views. Photograph by M. Dirr.*

Announcing

"The Teeming Plant Life of the Tropics"

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Refreshments will be served at 7:30 p.m. Program will begin promptly at 8:00 p.m. All lectures take place at the Harvard University Herbaria Building, 22 Divinity Avenue, Cambridge, Mass.

ARNOLDIA

the magazine of the arnold arboretum

Sept./Oct.
1981

THE ARNOLD ARBORETUM of HARVARD UNIVERSITY
THE ARBORWAY · JAMAICA PLAIN · MASSACHUSETTS 02130 · U.S.A.

Dear Arnoldia Subscriber:

Over the past volume (41) you may have noticed some changes in Arnoldia. We hope that you have, and we hope that you find them to be improvements. The addition of color, and a more varied photographic format have helped to update our appearance.

The coming volume (42) will bring further changes, one of which will be a change in frequency of issue. As of January 1982, Arnoldia will be issued quarterly, rather than bi-monthly, in winter, spring, summer, and fall. The total number of pages per volume will remain the same. This will allow us more time to develop each number, while at the same time conserving resources. In addition to the four issues of Arnoldia annually, subscribers will continue to receive the annual report of the Arnold Arboretum, which will be published separately, beginning with 1982. Subscription prices will remain at their 1981 rate.

In addition to regular features by the Arnold Arboretum's distinguished horticultural staff, Volume 42 will include an issue devoted to the 17th century Dutch painter, Jacob van Ruisdael, and his contribution to the art of botanical representation. Written by Peter Shaw Ashton, Seymour Slive, and Alice Davies, this issue will be produced in conjunction with the Fogg Art Museum's exhibition of van Ruisdael's paintings, opening in January, 1982. Another issue will bring a special report on the state of the elm by Harvard Forest botanists Martin Zimmermann, D. N. Roy, and Dennis Newbanks.

As we look forward to coming issues, we invite you to join us in the excitement of discovering plants and horticulture through the pages of Arnoldia.

Sincerely yours,

Carl Lobig

Carl Lobig
Editor

ARNOLDIA

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Contents

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On the front cover: Blossoms of Indigofera kirilowii, *rich in color saturation and color intensity. On the back cover: the flowers of* Neillia sinensis.

Shrubs for Hillsides and Embankments

by GARY KOLLER

Anyone who has looked down from an airplane window on the face of modern America will know that it is a compromise: a crazy quilt knitting together the need for vast, regular surfaces on which to travel and to build, and the desire to maintain the natural beauty of what was once the great wilderness.

Grading the land for countless miles of mammoth airports or sprawling apartment complexes leaves scars that take the form of rocky embankments. These slopes are extensive and varied both in physical size and in the quality and depth of the soil. Rarely do we give a thought to the special problems created by these surfaces, but for the landscape architect, they are a constant concern.

After the bulldozers and grading machines have created a slope, the matter of greatest concern is how these slopes will be stabilized, how soil erosion can be controlled, and how the finished bank surface will be maintained.

Most often banks are planted with grass, herbaceous perennials such as crown vetch (*Coronilla varia*), or wild flower seed mixes. These plantings are largely unmaintained and through natural succession allowed to revert to a woodland condition.

In key locations or areas of higher visibility and use, trees, or masses of shrubs are planted as part of a landscape development scheme. In most cases there is little or no care given to these plant-

ings. It becomes essential, therefore, to select species and varieties for their ability to adapt to varied climatic, and environmental conditions. Too often, the developer selects plants for their ornamental value rather than those that would best survive. At the same time, landscape architects and developers are largely restricted to those plants that are commercially available. Other factors which influence selection include the size and quantity of the plants needed and the price, which must be competitive with, if not lower than, other methods of covering the slopes.

In selecting shrubs for bank plantings in North Temperate Zone locations, most landscape architects, nurserymen, and horticulturists limit themselves to the few old standbys such as: *Cotoneaster* spp., *Forsythia* spp., *Juniperus* spp., *Myrica pensylvanica, Euonymus alata* 'Compacta', *Rosa rugosa, Rosa virginiana,* or *Rosa wichuraiana.* These plants are all excellent choices for large-scale landscape plantings, as long as they are suited to the environmental conditions that exist at each individual site. In approaching the problem of selecting shrubs for hillsides and embankments, I chose not to reiterate a list of those plants already known, used, and widely discussed in the horticultural literature. Instead, I trekked through the Arnold Arboretum. Here, I looked for plants with the following characteristics: a crown, or foliage canopy, dense enough to suppress weed competition; a stoloniferous or twiggy branching system arising from soil level; suitability to mass planting and ability to interface well with adjacent plants; and longevity as well as vigor of regrowth and aggressiveness. Strangely enough, most of these are characteristics of successful "weeds." Ornamental traits, except crisp green foliage, were not even considered.

What follows is a compendium of the plants at the Arnold Arboretum which appear, from all indications, to have the desired qualities. I feel that they easily fit into the milieu of a bank or mass planting and should form dense, vigorous stands. However, without periodic maintenance, they cannot be expected to completely eliminate the encroachment of the area's natural vegetation.

Many of the plants listed are poorly known, even in botanical gardens and are rare, or in some cases impossible to find in the current American nursery trade. I offer my observations with the hope that these plants will be brought to the attention of people interested in testing them, in actual long-term, steep bank situations.

In the ensuing discussion, my observations are largely drawn from individual plants. Therefore, I expect the species and varieties to exhibit a variation in density, height, vigor and growth rate, as well as in their level of ornamental merit. Most of the plants would be enhanced by selecting individuals which have superior traits and then producing them vegetatively to maintain specific characteristics.

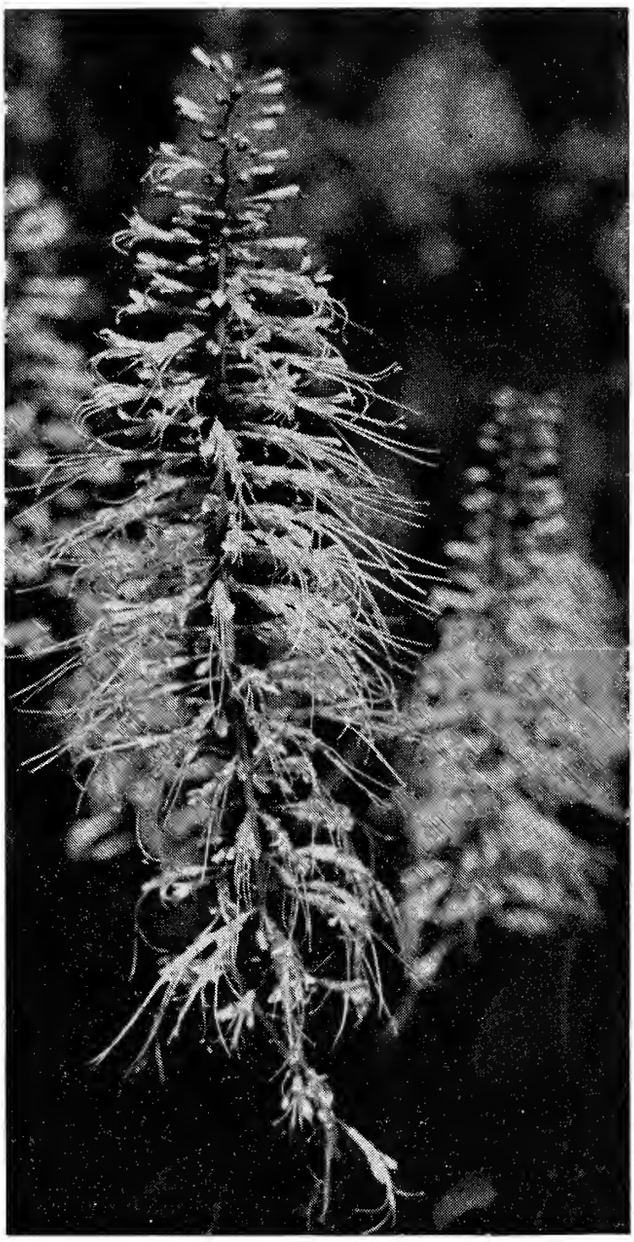
What follows is my list of the deciduous shrubs that I would suggest to stabilize hillsides and embankments.

Acanthopanax sieboldianus
fiveleaf aralia

Height: 6–10 feet
Spread: 6–10 feet
Environment: Sun to moderate shade
Hardy to −25°F.
Native to Japan

This ironclad shrub was once well known and much used as a landscape plant; however, it is seldom seen today and the reasons are not at all evident. While this plant could never be described as a showy ornamental, its superior traits include lustrous green, pest-free foliage; longevity despite neglect and abuse; and adaptability to shearing and shaping. Presently, when it is used, it is generally clipped as a hedge. However, it can be more beautifully used as a colony, when it is allowed to become an informal, impenetrable mass. It has the virtue of suckering freely from underground stems, and the attribute of bearing occasional spines at the base of a leaf or leaf cluster, thus discouraging pedestrian or large animal traffic.

The fiveleaf aralia tolerates drought and poor soils, dust, smoke and the difficulties of an urban environment as well as any shrub. Its growth rate is moderate. Use of this plant is feasible as it is currently available in the nursery trade. When one wants a plant with fresh, attractive foliage throughout the summer, *Acanthopanax sieboldianus* is a first-rate choice.



Aesculus parviflora
bottlebrush buckeye

Height: 10–12 feet
Spread: 6–10 feet or more
Environment: Sun to moderate shade
Hardy to −25°F.
Native to Georgia and Alabama

A flowering period in early July, clear amber autumn foliage colors and a multi-layered canopy make this a distinct and desirable plant for ornamental landscaping. Bottlebrush buckeye is a large, spreading shrub, with a rounded canopy which grades from a central high point down to the soil level at the outer perimeter. A clump resembles a grove of young trees planted closely together, and when established, repeats the contours of the planting locale. Large cylindrical clusters of small, white flowers appear in early to mid-July and look similar to the brushes used to clean bottles. Flowering occurs even on young plants. Fruit is infrequent, but when found consists of a small rounded nut, enclosed in a dehiscent husk, the ripening of which is eagerly awaited by squirrels.

Bottlebrush buckeye slowly creeps outward by stoloniferous stems. Growth, which is dense, eliminates the growth of most herbaceous plants and low shrubs, but occasionally a volunteer tree seedling will grow and overtop the mass. When desired these volunteers can be removed, or if the bottlebrush buckeye is used in a naturalistic setting, the trees can remain as companion plants, as the buckeye is shade tolerant.

From my observations, this plant is slow to re-establish itself after transplanting, but my experience is based on bare-root divisions rather than on container or field-grown stock. I am told by nurserymen that it is slow to work up to a saleable landscape size. The apparent slowness of recovery and growth will restrict its use to those locations where some weeding maintenance can be provided to help the colony establish density. Once established, bottlebrush buckeye is attractive and essentially trouble-free. I have heard of plants which exhibit the marginal leaf scorch so common to *Aesculus;* however, I have not seen this myself in the Boston area.

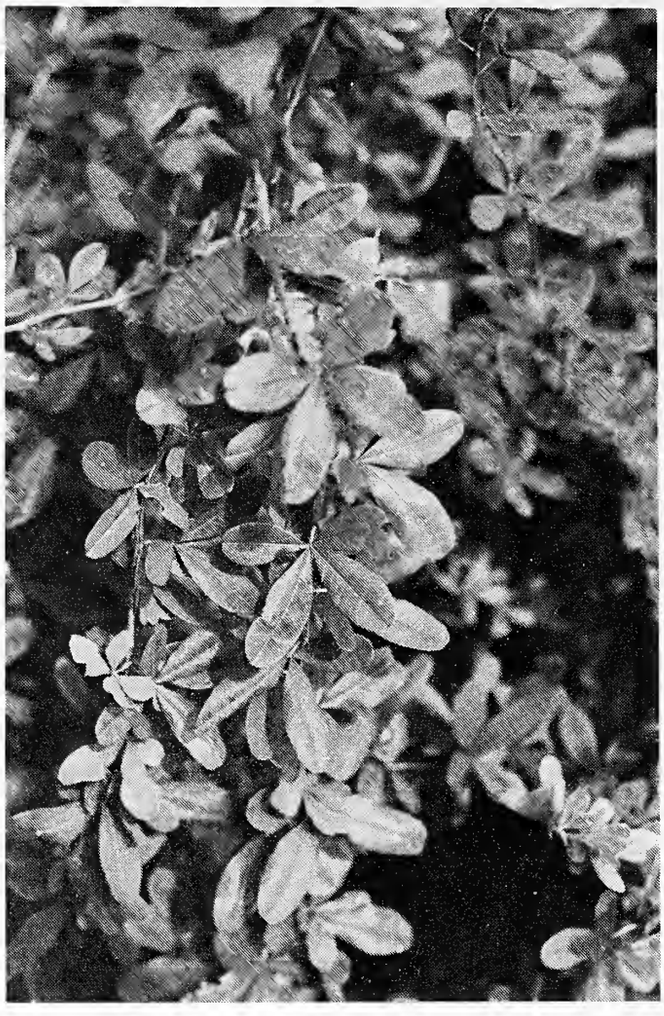
Landscape architects should consider using this in combination with trees as an outstanding cover for the low mounds frequently used as a device to screen industrial, municipal and institutional buildings. It would also be useful as a flowering shrub for summer resort and recreational areas.

Caragana frutex
Russian pea shrub

Height: 4–8 feet
Spread: 6–10 feet
Environment: Full sun
Hardy to: −25°F.
Native from Turkestan to Siberia

This tough shrub, which is almost unknown outside of botanical gardens, has several qualities to indicate that it might be a superb bank plant. It is relatively low-growing dense and vigorous, allowing no weeds to penetrate the upper foliage canopy. It is very persistent, requires little care to thrive, and it has tolerance for cold temperature rivaled by few other woody plants.

Ornamental qualities are limited to abundant quantities of small, bright yellow flowers which appear in early May. Branches are thin and delicate and the habit is more erect than *Caragana sinica*. New season twig growth is four to eight inches long and the branches are unarmed. Our plant, AA 20870, is four feet tall and twelve feet across, and the mature foliage is a dense and healthy, bluish-green. The younger foliage is lighter, and yellowish along the edge, which is perhaps a nutritional deficiency, rather than typical leaf color. There is a small amount of twig dieback evident but not enough to cause alarm. The general appearance of the plant from a distance is one of a flat-topped mass, well faced with foliage right to the soil level. Nurserymen believe that this plant would be a good choice for mass plantings, but because of the small demand it is not presently a commercially viable crop, and therefore, difficult to procure.



Caragana sinica
Chinese pea shrub

Height: 5–6 feet
Spread: 6–12 feet
Environment: Full sun
Hardy to −30°F.
(Northern range of hardiness still needs to be determined)
Native to Northern China

It is unfortunate that as horticulturists we tend to emphasize too much a plant's ornamental qualities, ignoring its potential for adapting to difficult environmental niches. *Caragana sinica*, the Chinese pea shrub is a charming little plant which deserves more than the cursory review it has had in the past.

Caragana sinica forms a tapering mound which is dense and faces itself beautifully to the soil level. The older foliage has a dull luster and a rich green color slightly tinged with blue, while the younger leaves are smaller in size and yellowish-green. The leaf radius terminates in a sharp point giving the plants a somewhat spiny character which is retained even after the leaves have fallen. The branches are thin and wispy and somewhat uneven in their height, with an informal appearance. The summer foliage is better than on *Caragana frutex* and the plant appears more robust, with no visible signs of dieback or dead twigs. Flowers, which appear in May, are presented individually among the foliage and are yellow with a slight reddish cast.

The plant from which I drew my observations was collected in the wilds of Weichang, China in 1909, by W. Purdom. At 72 years of age, this plant is five feet tall and twelve feet across, forming a perfect tapering mound. While it is surrounded by a tall coarse grass, there is no evidence of the grass penetrating the upper leaf canopy of the plant, even at the outer edges.

Clerodendrum trichotomum
harlequin glorybower

Height: 6–18 feet
Spread: 6–12 feet
Environment: Full sun to light shade
Hardiness: −5°F.
Native to Japan and China

At the Arnold Arboretum, this plant appears to have a dense robust habit. Perhaps this is due to the fact that it freezes back to the soil line almost every year encouraging more suckering from the root system. Our plants have coarse, dark green foliage, robust new growth from soil level and, due to the strongly stoloniferous habit, a dense bushiness directly to the ground. The plant bears small fragrant white flowers in late summer, followed by bright blue fruits the size of peas. The unique and intense blue fruit color is set off against the persistent calyx lobes which become more fleshy and crimson as the drupes ripen, making the plant visually striking when viewed from close by.

I have seen *Clerodendrum trichotomum* in areas where it has naturalized itself into the edge of woodlands. There, with shade, it becomes more open and less likely to quell vigorous weedy competitors.

In localities where this plant is not likely to die back each winter due to the cold, it would probably be best to cut the shrub back to the soil level annually or biennially in the spring to encourage the large, robust foliage which is common to sucker growth, producing a plant five to eight feet tall by summer's end. With this plant, management techniques will clearly be an important factor in maintaining a dense canopy.

The harlequin glorybower is less likely to be a stellar success as a colony than others listed here, but I think it deserves a trial, for once established, it should colonize adjacent areas with its seed.

Deutzia gracilis
slender deutzia

Height: 3 feet
Spread: 2–4 feet
Environment: Full sun to light shade
Handy to −20°F.
Native to Japan

This "low maintenance" shrub is a superb choice for use in foreground plantings. In the home landscape it has generally been given a crew cut or misplaced behind taller or more robust plants, obscuring its outstanding characteristics. When grouped together and allowed to grow unclipped, this plant can be used to create a pattern or distinctly shaped area. It can also be used more informally. At maturity the plant has slender arching branches and forms a dense spreading mound. Due to its compact habit, it never gets out of bounds. Flowers, reliable in their annual May appearance, are borne in graceful terminal clusters.

Along the northern edge of this plant's hardiness range, *Deuzia gracilis* may die back to the soil each year, but it will still form a robust mound of new stems by early summer.

Diervilla sessilifolia
southern bush-honeysuckle

Height: 3–5 feet tall
Spread: 3–5 feet or more
Environment: Full sun to moderate shade
Hardy to −20°F.
Native from North Carolina to Georgia and Alabama

Diervilla sessilifolia is a native American shrub with dense stoloniferous habit, modest size, adaptability to a wide range of light exposures and soil conditions, and a summer flowering period. Southern bush-honeysuckle will thrive under light conditions which range from sunny to those areas with moderate shade. In shade, the plant's habit will change moderately, becoming thinner and more open and bearing fewer flowers.

The habit of the plant is mound-like, formed by loosely arching branches arising from the denser colony below. For new season growth, stem diameter is thin and the visual quality enhanced by branchlets of rich purple along the top or sunny side. In locations where the plant experiences physiological stress caused by drought or full sun, the summer foliage often takes on a purplish-red cast. During the autumn, the plant displays rich purple-bronze colors prior to defoliation. Small terminal flowers, clusters of which are pretty but not showy, appear in early to mid-July, on new season wood.

Southern bush-honeysuckle would probably exhibit best growth and density if mowed to the ground annually or biennially. *Diervilla sessilifolia* is presently offered by several of the nation's large wholesale nurseries.

Indigofera kirilowii
kirilow indigo

Height: 2–3 feet
Spread: 2–4 feet
Environment: Full sun
Hardy to −20°F.
Native to N. China and Korea

A delightful small shrub with erect stems and light green, pinnately compound foliage. Flowers which appear on new season growth in mid-June are a bright rose-pink, abundant, and persist for three to four weeks.

At the Case Estates of the Arnold Arboretum, in Weston, Massachusetts, there is a planting which was cut to the ground one autumn. During the winter the stem stubble and the fibrous root system were sufficient to prevent or reduce soil erosion. The following spring, new growth developed and the plant returned to its original height all in one season. The plant flowered, but a bit later than normal. As a result of this experience, we believe that kirilow indigo might best be managed by mowing annually or biennially. This mowing would have the effect of thickening growth and invigorating the plants, as well as eliminating the encroachment of woody weeds. A legume, kirilow indigo has the advantage of being able to fix nitrogen on sites with poor or impoverished soils.

Indigofera kirilowii is easily transplanted and should be an excellent subject for container growth in nurseries. In addition to being considered as a part of mass plantings, kirilow indigo should be viewed as a potential flowering shrub for low maintenance landscapes, or at resort areas where summer flowering plants are desired (see front cover).

Kerria japonica
Japanese kerria

Height: 3–6 feet
Spread: 3–6 feet
Environment: Full sun to moderate shade
Hardy to −20°F.
Native to C. and W. China

Kerria japonica of Japanese kerria is used only rarely as a mass planting on difficult banks or to colonize difficult planting sites. With creativity it could be used far more effectively. *Kerria* forms a dense, rounded shrub with slender arching branches. The thin stems remain green year round. This makes them somewhat showy in the winter landscape, when most shrubs are dull tan or brown and lifeless in their appearance. Foliage is a bright green in summer and in autumn it turns pale yellow.

The typical variety is useful for mass planting as it is dense and vigorously aggressive in colonizing a site. The floral color of the single flowered variety tends to be pale yellow. This color works well as an element in a naturalized planting scheme. However, they have a major disadvantage in that the flowers rapidly fade or bleach to white when the plant is grown in full sun. The full flush of flowers occurs in early May with the main flowering period lasting two to three weeks. However, scattered blossoms occur throughout the growing season.

Useful varieties include: *pleniflora* with double orange-yellow flowers, and less vigorous than the type; and *picta* which has leaves bordered with white markings, and normally grows only 24–30 inches tall. *Picta* is the least vigorous of the lot, and has a strong tendency to produce green branches which need to be removed lest they overtake the variegated form.

While *Kerria* is essentially maintenance-free, it does need occasional thinning and renewal pruning to keep the plant vigorous and the stems bright green and in peak display condition. The plant is listed as hardy to −20°F, but our plants exhibited dieback with a low temperature of −6°F during the winter of 1980–81, a year which was, however, both excessively drier and colder than many of the recent past.

Neillia sinensis
Chinese neillia

Height: 5–6 feet
Spread: 6–10 feet or more
Environment: Full sun to light shade
Hardy to −10°F (perhaps lower if more widely tested)
Native to Central China

If one were to point to a little-known plant at the Arnold Arboretum which has potential as a superior bank plant with fresh, attractive foliage all summer long, the first choice would be *Neillia sinensis*. This plant is little known and remains rare even in botanical gardens. Our plant was collected as seed from the wild in 1907 by E. H. Wilson at Hsing-sham Hsien, W. Hupeh, China. At 73 years of age, this plant is five to six feet tall and spreads sixteen feet across.

Neillia forms a dense, billowy, irregular mound with gracefully arching stems that brush the ground. The foliage is dark green and remains vibrant, healthy, and most attractive throughout the entire growing season. The young stems and leaf petioles are rich maroon above and green beneath. New season growth on our long-established plant varies from eight to twenty-four inches. This plant is so densely branched and so strongly stoloniferous that few plants can compete successfully. Chinese neillia is a type of plant which could be well suited to mass plantings down the median strip of a super-highway. Here it could successfully recover from mowing or accidental burning. The height and density of the plant should make it particularly useful in this application. A well-established mass planting could substantially absorb the impact and reduce the speed of a misguided automobile.

However, from an ornamental perspective, this plant has little to offer other than small, rose-pink cylindrical flowers. It is delicate and

attractive when in blossom but, the flowers are insignificant from a distance.

Our experience with container trials indicates that *Neillia* adapts well to this growing technique. Chinese neillia is easy to propagate from divisions or stem cuttings, and grows rapidly and adapts quickly to new growing locations — all attributes which give it the potential of becoming a popular item for wholesale nurseries (see back cover).

Prinsepia sinensis
cherry prinsepia

Height: 7–12 feet
Spread: 10–15 feet
Environment: Full sun
Hardy to −25°F (perhaps lower if more widely tested)
Native to NW. China (Manchuria)

This large spreading shrub is among the first plants to leaf out each season at the Arnold Arboretum, providing a green spot in the midst of a still lingering winter landscape. The plant has a robust appearance with small leaves that vary from dark green to more yellow green. While it does not seem to be stoloniferous, it's canopy and branching habit is extremely dense precluding the growth of most weeds. Branches which arise from the soil are stiffly upright until they reach about three feet in height, then they arch outward and sweep down towards the ground. Flowers and fruit are of little note; the autumn foliage color is a clear yellow.

Rhus aromatica 'Gro-Low'

fragrant sumac

Height: 2½ feet
Spread: 4–6 feet
Environment: Full sun to moderate shade
Hardy to −35°F.
Native from Kansas to Minnesota, south to Florida and Louisiana

It is unfortunate that we view the sumacs as weeds. As a group they possess an aggressiveness, tenacity, and longevity shared by few other plants. They do vary considerably in height, density, growth rate, and ornamental qualities and, therefore, some selection will be helpful to integrate the best forms into the nursery industry.

Rhus aromatica, the fragrant sumac, forms a dense carpet which varies in its height and growth habit. One of the best forms presently available is a selection offered under the name of 'Gro-Low'. This plant was selected and introduced by Ralph Synnestvedt and Associates, Inc., 3602 Glenview Road, Glenview, Illinois 60025. The following description is excerpted from their 1978–79 catalog: "Cutting grown selection. This plant spreads rapidly and stays low (30 in.); deep rooted, this plant is working well on highway banks." A planting of *Rhus aromatica* was established in the ground cover trials at the Case Estates during the summer of 1978. The rooted cuttings, which were one or perhaps two years old, took three growing seasons to fill in completely. Growth became full and dense at the base and somewhat lighter and wispy at the top. However, the surface remained regular and even. There has been no noticeable insect, disease, or drought injury. This planting has attracted considerable attention from visiting landscape architects.

Rhus copallina
shining sumac

Height: 20–30 feet
Spread: 20–30 feet
Environment: Full sun
Hardy to −10°F.
Native from Maine and Ontario to Minnesota, south to Florida and Texas

Rhus copallina is one of the most handsome sumacs. The summer leaf is a lustrous dark green followed by brilliant red autumn colors. Flowers appear in dense terminal clusters in July or August and are greenish-yellow in appearance. Shining sumac, a stoloniferous plant, is relatively compact in youth, but with age, becomes more open and spreading.

The landscape uses of this plant could be enhanced by the selection of superior forms. Unfortunately, this fine native plant is, at present, rarely offered for sale.

Rosa acicularis
prickly rose

Height: 3–4 feet
Spread: 6–10 feet
Environment: Full sun to light shade
Hardy to −30°F or lower
Native to northern North America and NE. Asia

Several species of roses deserve recognition for their aggressive behavior rather than for their delicacy or floral effect. If vigor and aggressiveness are admirable traits in a plant, then *Rosa acicularis* should be a first prize winner. One of the notable accessions in the Arboretum's collections is AA 17134, received as seed collected in 1909 near Boulder, Colorado. At 72 years of age, this plant is four-and-a-half feet tall, spreads fifteen feet and remains full and dense. It would consume a greater space if not for the fact that it is occasionally grubbed out to reduce the size of the colony.

Our plants form a mound with a somewhat irregular surface due to unevenness of branches. The mound tapers allowing the plant to be full and tight to the soil level. Summer foliage is a dull light green and the autumn foliage, a pale yellow. Rose pink flowers almost two inches across are borne singly and appear in great profusion for us in early June. Blossoms are followed by bright scarlet rose hips which are held on slender stalks. *Rosa acicularis* is an extremely variable plant. Some forms or races would undoubtedly be better as mass plantings on banks than other plants of the same species. While, as a flowering plant, this is not a superior rose, it certainly is superior to most of the roses presently offered for mass plantings.

In order to achieve the best effect, selections need to be made which are dense, aggressive, and as floriferous as possible.

Rosa davurica
dahurian rose

Height: 5–8 feet
Spread: 7–10 feet
Environment: Full sun
Hardy to −20°F (perhaps lower)
Native to N. China and N. Korea

This rose is said to grow on the lower, sunny, stony parts of the mountains of Northern Korea, its native habitat. Our plant (AA 1177-1-A) was grown from a cutting in 1923, and at 58 years of age is five feet tall and spreads fifteen feet. This reflects severe pruning three years ago, as well as grubbing to control spread. Growth is dense, upright, and vigorous. Foliage is large and somewhat coarse. The dull blue-green foliage color is rich and vibrant, in its own way. The young, new season stems are a lime green and contrast with the foliage. Branches at the outer edge droop slightly allowing complete coverage to the soil level.

Flowers are single, rose to rose-purple, and they are followed by globular hips which vary from reddish-yellow to red.

Rosa × *malyi*
maly rose

Height: 2–3 feet
Spread: 5–10 feet
Environment: Full sun
Hardy to −20°F. (perhaps lower)
Hybrid origin: Parents thought to be *R. pendulina* × *R. spinosissima*

A low growing, densely stoloniferous rose, maly rose is tallest in the center and tapers down to approximately one foot along the edges. Leaves are small and blue-green, and, as of the mid-July inspection, exhibited a tiny amount of powdery mildew. Flowers are solitary, single, and red. The hips are ⅜ inches across, dull red, and smooth.

Rosa pendulina
drophip rose

Height: 3–6 feet
Spread: 6–10 feet or more
Environment: Full sun
Hardy to −10°F.
Native to S. and C. Europe

Rosa pendulina is more irregular in its habit than the other roses discussed. Our oldest plant was propagated from a cutting taken in 1905 and today is six feet tall and fourteen feet across forming a dense mound. Foliage is a dull, light green. Flowers are solitary, rose or rose-purple in color, and occur in early June. Fruit is oblong, nodding, bright red, and most attractive in the autumn landscape.

Rosa primula
primrose rose

Height: 5–8 feet
Spread: 6–8 feet
Environment: Full sun
Hardy to −10°F
Native from Turkestan to N. China

Of all the roses in the Arnold Arboretum's collection, this is among the best for delightful foliage. The leaves bear nine to fifteen tiny leaflets giving a fine texture. Leaves are light blue-green, highly lustrous and in the wind or with intense sunshine, the foliage appears to sparkle. The vigorous young branches, as well as the thorns, are a bright red-purple and contrast handsomely with the delicate foliage.

This plant may not be as aggressive as the others included, but it certainly will hold its own against competition. Stems are thin, upright and dense. The greatest density is at the base with the upper area of the branches being less uniform in height and less dense. The overall effect of the plant is more square than mound-like, for the top is essentially flat.

Flowers appear early in the flowering sequence of our rose collection and are at their peak in late May. Blossoms are single, one-and-a-half inches across and pale yellow to yellowish-white; rose hips are small and turn red in the autumn. My description of the general character of this plant would include such terms as refined, sophisticated and desirable.

Rosa spinosissima var. *altaica*
altai Scotch rose

Height: 2–4 feet
Spread: 6–12 feet
Environment: Full sun
Hardy to −20°F
Native to the Altai Mountains of Siberia

Rosa spinosissima as a species tends to be a highly desirable shrub for colonizing banks. However, it has a wide natural distribution and, therefore, exhibits much variation in vigor, density, aggressiveness, and ornamental desirability.

Rosa spinosissima var. *altaica* is recommended here because it is a more robust form. In late May or early June, it is freely loaded with large, lemon-white blossoms, followed by black hips during the autumn.

Another desirable form is *Rosa spinosissima* var. *lutea* which is also dense and vigorous, but in addition, bears primrose-yellow flowers and has beautiful dark green foliage. I am told by members of the New England Rose Society that this rose species responds to transplanting more rapidly if it is given water and provided with fertilizer during the first summer to help it become established. Once established, the Scotch rose can be expected to last indefinitely.

Securinega suffruticosa
asiatic securinega

Height: 3–6 feet
Spread: 3–6 feet
Environment: Full sun
Hardy to −10°F
Native to NE. Asia

This dense, bushy shrub bears thin, willowy branches, clad with bright green leaves. Flowers and fruit are relatively insignificant. Unlike most of the other shrubs, it does not appear to be stoloniferous, but rather it branches freely from the base. In order to keep it dense, it may need to be pruned to the ground every two to three seasons. This theory needs to be tested under field conditions. It is recommended here because of the vigor and attractive foliage it exhibits in our collection.

Sorbaria sorbifolia
Ural false spirea

Height: 5–10 feet
Spread: 6–10 feet
Environment: Full sun to light shade
Hardy to −50°F.
Native from N. Asia to Japan

Mention the name Ural false spirea and most people either do not know of it, or discount its use because of size. Unfortunately, people tend to see only its capacity to overwhelm a small garden. Instead, they might well look to its potential to solve difficult landscaping problems. For years, the *Sorbaria* species in the shrub collection at the Arboretum have presented a management problem. They were so prolific in their growth that they quickly outgrew their space and needed to be pruned back severely every year. As a result, they required annual maintenance and always appeared to be butchered rather than exhibiting their natural billowy shape. Here was a classic example of a good plant incorrectly sited. In reviewing the management of the shrubs at the Arboretum, we decided to tie together what was viewed as a problem shrub with a problem landscape maintenance area — the steep, grass covered slope adjacent to the State Biological Laboratory. Here, its unusually rampant growth can help reduce mowing, by covering as much of the bank as possible. These plants were transplanted during fall 1980 from the shrub collection, as divisions, from the existing mass. As of August 1981, the plants have recovered and while thin in density, appear to have suffered little loss of the individual divisions. The plants will flower even though they have been in their new location for less than one year.

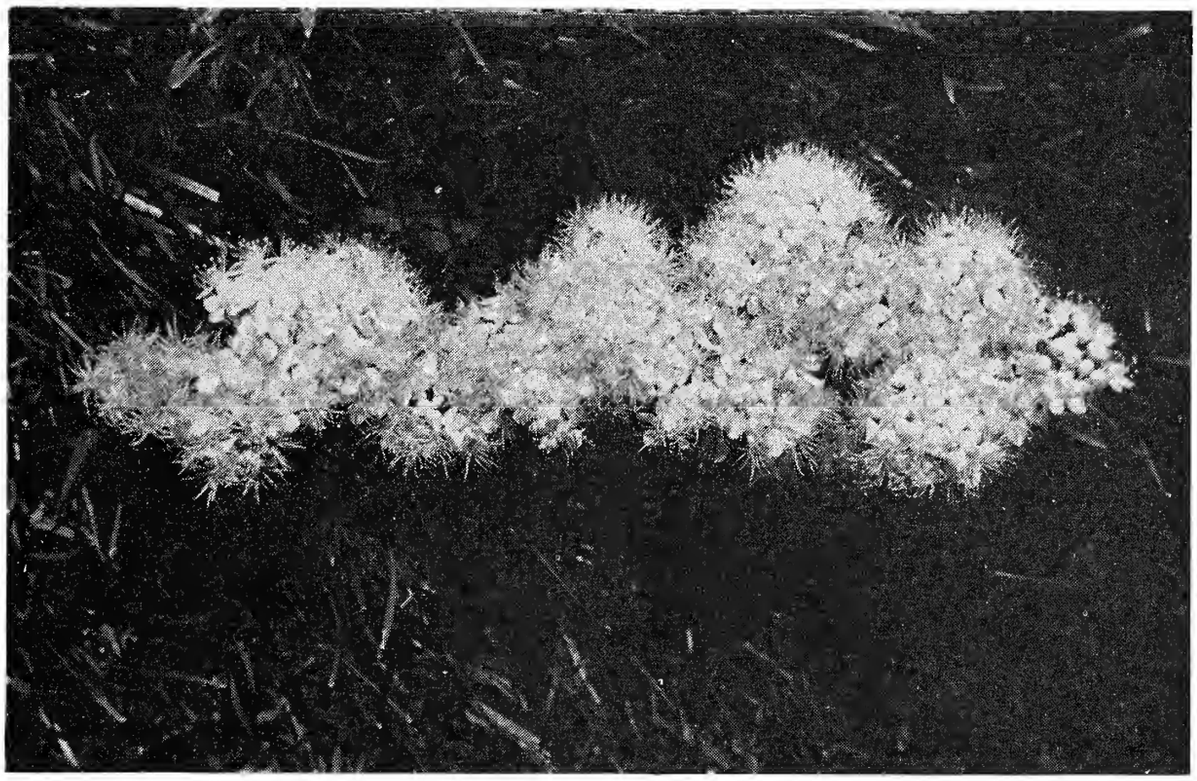
Sorbaria forms large shrubs with attractive light green, pinnately compound foliage. Autumn color is pale yellow and unremarkable. They blossom in July or August with large terminal clusters of

creamy-white flowers, resembling large spirea sprays. The blossoms are most ornamental and delightful in their mid-summer presentation.

Attributes include ease of propagation, rapid reestablishment in new locations, freedom from pests, and aggressive colonization of poor soil types. They are amazingly salt tolerant. I've seen plants grow along the coast within sight of the ocean in both Maine and Rhode Island. They do appear to have a reduced size when grown in dry or extremely shaded locations.

Sorbaria forms a shrub which might benefit from periodic pruning or mowing to encourage young vigorous stems, increased density, and more full-bodied flower clusters.

The *Sorbaria* best known and most frequently grown is *S. sorbifolia*. However, I would recommend that people review the attributes of *S. aitchisonii* for the foliage of this plant possesses a darker green, more vibrant appearance and shines in the summer sun.



Spiraea albiflora
Japanese white spirea

Height: 1½–3 feet
Spread: 3–5 feet
Environment: Full sun to light shade
Hardy to −20°F.
Native to Japan

The Japanese white spirea forms a dense, low mass with large fleecy white flowers. Generally summer foliage is a dull green and not showy; however, a few leaves exhibit a purple-red tinge. The best long-term maintenance might be to cut the whole plant down occasionally in order to thicken the mass and keep it populated by young, robust growth.

Spiraea × *arguta* 'Grefsteini'

Grefsteini garland spirea

Height: 3 feet
Spread: 3–5 feet
Environment: Full sun to light shade
Hardy to −15°F. (perhaps lower)
Hybrid origin

We received this *Spiraea* (AA 418-65) from the Old Farm Nurseries in Boskoop, Holland in 1965. I have never seen it listed elsewhere and wonder if it may not be synonymous with another cultivar. However, the plant as it exists for us can be described as follows.

At sixteen years of age, from a rooted layer, it is three feet tall and spreads by stolons three to five feet. It blooms at the same time as *Spiraea* × *arguta* 'Compacta' but is vastly superior in flowers, form, and density. It is a first rate plant, densely packed with thin wiry stems which are upright, forming almost a level top or surface. The general habit effect is informal. The leaves are narrow and lance shaped, pale green with a yellow-gray cast, and have a delicate appearance and fine texture. Flowers are abundant and pure white and both larger and fuller than *S. arguta* 'Compacta'. This plant should make a delightful mass planting, low informal hedge, or specimen plant.

Old Farms Nursery describes it in the 1964–65 catalog as "New, pure white, exceptionally large flowers." At the Arboretum, 'Grefsteini' is among the best of our *Spiraea* representatives.

Viburnum rafinesquianum
downy leaved arrowwood

Height: 6–8 feet
Spread: 5–10 feet
Environment: Full sun to light shade
Hardy to −50°F.
Native to eastern North America

Landscape architects who seek native plants to establish naturalistic settings should find this viburnum useful from a number of perspectives. It has an informal billowy habit; is more cold hardy than *Viburnum dilatatum* and *Viburnum dentatum;* it forms persistent colonies and is of the easiest culture.

Flat clusters of creamy white flowers appear in late May or early June and, while small in size, are abundant in number. They are followed by small clusters of blue-black fruit which ripens in the autumn. Autumn foliage is a dull bronze-purple. While this viburnum may not be as spectacular in fruit or autumn color as *Viburnum dilatatum,* it appears to have a greater longevity. Our finest plant (AA 17974) which grows in full sun, was grown from seed in 1880. As of July 1981, it is six to eight feet tall and spreads in a narrow band between driveway and sidewalk for a distance of thirty feet. On the sun side, the plant is dense and full to the soil line, but it is a bit thinner on the side lightly shaded by a tree. The upper foliage surface is uneven giving an informal contour to the surface of the mass. After 101 years, this mass planting remains robust in both growth and appearance.

Zenobia pulverulenta
zenobia

Height: 3–6 feet
Spread: 3–6 feet
Environment: Full sun to light shade
Hardy to −10°F.
Native from SE. Virginia to NE. South Carolina

Zenobia is a bit less robust than most of the foregoing plants. It is included here because in its native habitat it is a plant which inhabits low, swampy soils. As a landscape plant, it could be used in mass where the soil is acid and drainage is imperfect or impeded. It also thrives in drier sites with soil rich in organic matter.

At the Arboretum, there is a mass planting in the area of the juniper collection adjacent to the brook. These plants were acquired in 1930. One note in their history indicates that a grass fire burned them to the ground in 1965. Today, these plants are four feet tall, strongly stoloniferous, and while they exhibit some dead twigs, their general appearance is robust. Foliage is medium in texture and varies, from plant to plant, from light blue-green to medium green. The bluer leaved forms are most distinct in the landscape and more attractive in their visual quality. The zenobia plants blossom in June and bear large white bells clustered along the stem.

While the mass planting is dense, there are small plants of *Sambucus canadensis* invading the colony. From observation, it appears to be more suited to low wet sites and gentle banks, rather than steep slopes with impoverished soils. People who consider zenobia to be marginally hardy should keep in mind that during 1981, one of our plants celebrates 100 years at the Arnold Arboretum. However, for optimum landscape effect, it is a plant best used in more southern or milder locations. *Zenobia pulverulenta* is a native plant which certainly deserves greater landscape use.

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ARNOLDIA

the magazine of the arnold arboretum

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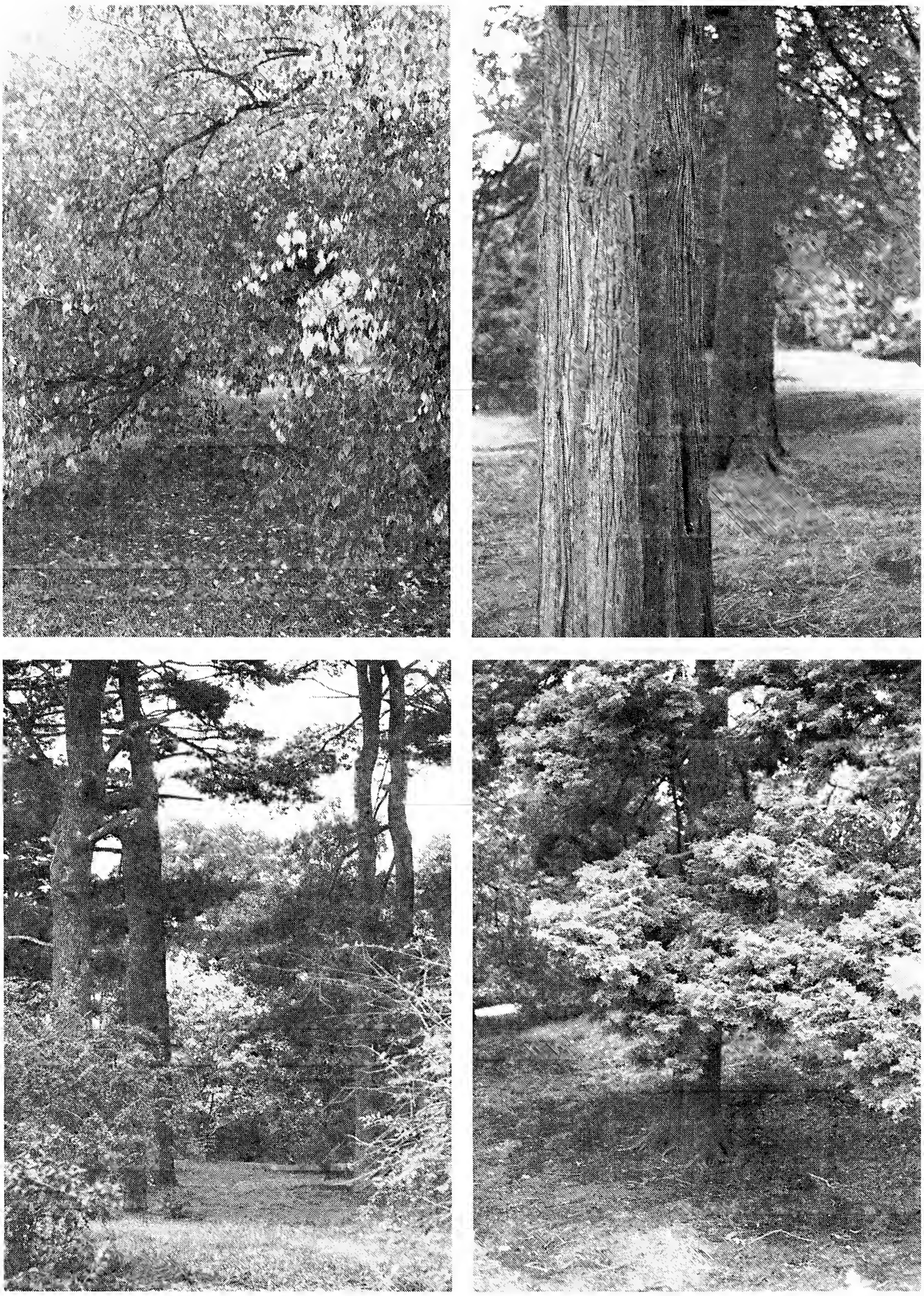
1981

The
Director's
Report



Four of the unique textures of the Arnold Arboretum in fall. Clockwise from top left: Euonymus bungeana *(winterberry euonymus);* Chamaecyparis pisifera *(Sawara falsecypress);* Chamaecyparis pisifera *f.* squarrosa *(moss Sawara falsecypress); and* Pinus strobus *(white pine). Photographs by C. Lobig (1, 3, 4) and R. E. Weaver, Jr. (2).*

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Contents

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Associate Editor

On the front cover: *Through the library windows of the Hunnewell Building the intense fall color of* Parthenocissus tricuspidata *(Boston ivy) is seen against the deep green of* Hedera helix *(English ivy). Photograph by C. Lobig.*
On the back cover: *The colorful ivies give way to the evergreens,* Tsuga canadensis *(Canada hemlock) and* Pinus strobus *(white pine), on the south side of the Hunnewell Building. Photograph by C. Lobig.*

Late summer is a special time in the broad meadow which spreads between the Hunnewell Administration Building and the Arborway. In the wet, peaty soil a wide array of herbaceous plants thrive. Bold texture comes from Iris pseudacorus *with sword-shaped leaves. Photograph by C. Lobig.*

The Director's Report

THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1981

On my arrival at Harvard two and one-half years ago, my first priority was to define future policy for the Arnold Arboretum, and in particular for the curation and development of its collections. I had come as a fervent advocate of the Arboretum as an institution. This advocacy was, and still is, based on certain convictions that I espouse as a biologist, and one belief in particular: that all biological endeavor must spring from a solid base of description in systematics. Systematic biology is the study of patterns of variation between organisms. It entails far more than naming and tabulation. Systematics above the level of the breeding population, and most other rigorous descriptive and analytical biology, requires comprehensive and well-curated collections and libraries, of which those of the Arnold Arboretum serve as a superb example. But I am also convinced that systematics is not an end in itself and therefore is most creative when pursued in the broad biological milieu provided by a university.

Armed with these premises, I used my first annual report to set out a policy for our collections which seeks to reconcile what I consider to be their principal function, that is, research, with their role in education and public amenity. The present report should be read in the context, then, of this first statement. I did not attempt to explain why collections are essential for systematic and, indirectly, most other biological research, and this was just as well, for I would have grossly

underestimated the complexity of the issue, particularly in the context of Harvard. But it is this question which I wish to address in my report this year.

The Arnold Arboretum is a museum facility that has, besides its staff, three major resources: the libraries, the herbaria, and the living collections. Their resources are particularly strong in materials from tropical Asia and the Far East; indeed, the Arnold Arboretum is the leading American institution for research into the botany of this area. Our collections are primarily (but by no means exclusively) dedicated to woody plants, and in particular to trees, while our living collections are exclusively North Temperate in origin. They thus complement those of the Gray Herbarium, the collections of which are primarily from the New World, the Farlow Herbarium of non-vascular plants, the Oakes Ames Orchid Herbarium, and the Herbarium of Economic Plants of the Botanical Museum.

What value do museum collections of long-lived plants now have in addressing the salient research issues of our time? We are now questioning the value of object-based research in many fields. The implications are grave, for a museum collection cannot be maintained, accessible to the scholar, if it is merely locked away in an air-conditioned space. Facilities such as those possessed by the Arnold Arboretum take time to build, cannot easily be changed to accommodate new directions in science, and absorb significant funds for maintenance. Unlike, say, the equally or more expensive equipment required for molecular biology, they cannot be periodically written off and replaced. The collections of necessity require staff with a high level of scholarship who actively and continuously use them for research. Nowhere is this more essential than in living collections, which take up public space, need constant and expensive attention, and decline with surprising rapidity if they do not receive the constant care and interest of scholars.

Research in the arts depends, it is being claimed, less and less on the original, and in that sense unique, works stored in the Fogg, and archeological research seldom now needs direct access to the stelae of the Peabody. In these cases photographic reproduction has made the collections available to researchers without need for access to the originals, while there has been a shift in interest from artifacts to the people who created them.

However, biological museum specimens differ in important respects from cultural artifacts. They cannot be reproduced; only the originals are of value to research. They each represent a subjectively selected fragment, or a whole individual in the case of a living collection, usually of a unique genotype which was itself sampled from a population of living organisms. Nevertheless, biological specimens generally have no rarity value, although again, some of our plant collections are rapidly accruing it as the species they represent decline in the wild. Collections document biological variation and diversity

and are hence ultimately essential for all biological inquiry. They serve as partial records of living populations, as evidence for their distribution, and as material for the study of those aspects of the biology of an organism which are manifested in the collected specimen. They are the primary evidence for patterns of variation from which paths of evolution are deduced, and are hence ultimately the basis for all hypotheses in evolutionary biology. Research on fossil organisms adds a time dimension to evolutionary hypothesis, as well as disclosing organisms whose morphology must be reconciled with the morphology of extant organisms. This underlies the importance of Harvard's outstanding paleontological collections, and the need for continued research strength in this area.

Although living collections cannot be a substitute for a natural population, they allow examples of plants which in nature may be growing on different continents to grow together. Living specimens are amenable to a wide range of experimental manipulation. Living plants have the important additional advantage that most can be vegetatively propagated in perpetuity, and their genotypes can hence be replicated for experiment as well as for conservation.

Plants possess certain distinct advantages for research, and the history of plant science reflects these potentials, in part. Their sedentary nature facilitates long-term study of processes of adaptation and selection in relation to growth, development, and mortality, while their modular construction and relative ease of asexual propagation permit replication of a single genotype. However, their lack of organization compared with higher animals, and their absence of locomotory, nervous, or obvious sensory systems, impose restrictions and help to explain the traditional emphasis on classification in botany. Many plants are long lived, and this restricts their potential for genetic and other experimentation. This is notably so in woody plants. But are we to ignore them on that account?

Systematics provides a framework, and thus the gateway, through which biologists can gain access to the diversity of the living world. The biological method will continue to be one of successive approximations. Systematic research cannot answer how biological processes take place, but through analysis of biological variation the systematist identifies patterns, and from them formulates hypotheses concerning these processes which then must be tested through experiment.

For example, the central integrating concept in whole-organism biology remains the theory of evolution. The processes of mutation and natural selection take place at the level of the individual organism, but influence evolution through changes in gene frequency in populations in nature. Research in population biology requires long-term observation in secure sites, of which the Harvard Forest, and the Concord Field Station of the Museum of Comparative Zoology, provide excellent examples. It is at these and lower levels of organizational scale, therefore, that mechanistic research into the processes of

evolution will be concentrated. But which populations and which organisms will provide the most appropriate information from which to generalize?

Genius and technological adeptness alone cannot make a great biologist. Experience, arising from prolonged and meticulous observation of the natural world, is equally essential. Systematics, though inherently synthetic and non-experimental above the species level, should not be regarded as less rigorous than experimental, and especially mechanistic, branches of biology. The approach in systematic biology does not differ from that of, say, the late Professor Cecilia Payne-Gaposchkin's, in her astonishing systematic analyses of the variable stars. Though descriptive biology remains an essential precursor and adjunct to experimental branches of our science, the two approaches in certain respects require different philosophies and skills, and this has led to a mutually damaging lack of communication, and even respect, between their practitioners.

In many areas, the reopening of paths of communication must await future technological innovation, since application of the mechanistic approach to biological research is restricted by the refractory nature of much biological material. Current advances in molecular and cell biology are confined to a small group of organisms which, due to a peculiar combination of characteristics, are most amenable to experimentation. But to what extent can our rapidly extending knowledge of *Escherichia coli, Drosophila melanogaster,* or even *Homo sapiens* be extrapolated to other organisms? There is no doubt that future research must be directed increasingly at developing the technology required to expand this dangerously slender base, and competently curated collections, particularly of living plants, will prove invaluable.

It is also true that systematics, except that based on population-level analyses, has been in the doldrums. This has been largely because systematists have been disinclined to discuss the theoretical basis of their scientific approach, and have considered classification as much an art as science. Hence, systematics has tended to be ignored by the rest of science. However, over the last 30 years techniques for analyzing new sets of characters, or simply for looking at the plant in new ways, have been developed and have given systematists vast amounts of new information. Advances in mathematical techniques, aided by the electronic computer, are permitting objective analysis of patterns of immense complexity. Perhaps more importantly, the recent revival of interest in the theoretical grounds of systematic biology enables systematists to utilize this information in critical studies of evolutionary relationships and to explore anew the relationships between morphology (in the broad sense), classification, and evolution.

Our institution, as a member of the community of museums and other institutions that comprise the Department of Organismic and Evolutionary Biology of Harvard University, has an excellent oppor-

tunity to make the diversity of the plant kingdom available to the experimental scientist. This must be done through broad yet rigorous monographic systematic research. There are many groups of animals and plants, notably most arthropod orders, fungi, and flowering plants, particularly those of the tropics, still awaiting monographic study. These groups are literally inaccessible to scientific investigation until their systematics have been advanced. As an example which typifies the systematic research of our staff, Dr. Peter Stevens's current monographic research in the tropical tree family Clusiaceae, and notably the large and extraordinarily complex genera *Calophyllum* and *Mesua*, is revealing contrasting and unexpected patterns of variation and diversity which permit him to formulate hypotheses concerning the evolution of trees in tropical forests. In a rather different way, Dr. Carroll Wood's monographic *Generic Flora of the Southeastern United States* brings together a wealth of information on all aspects of the biology of a group of plants which includes many whose phytogeography indicates a former vegetational connection between that region and temperate eastern Asia. Thus, it provides the essential background for research into this interesting stage in the evolution of the North Temperate flora.

There is, therefore, still a critical need to expand the descriptive and, especially, the systematic base of knowledge so that the most appropriate material for research into comparative and evolutionary plant biology can be identified. This requires rigorous scholarship and an aptitude for a particular kind of intellectual — though not necessarily technical — innovation. It is a paradox that systematics, which people think encumbered with history, old books, and Linnaeus, is more ahistorical than much research in physics and chemistry.

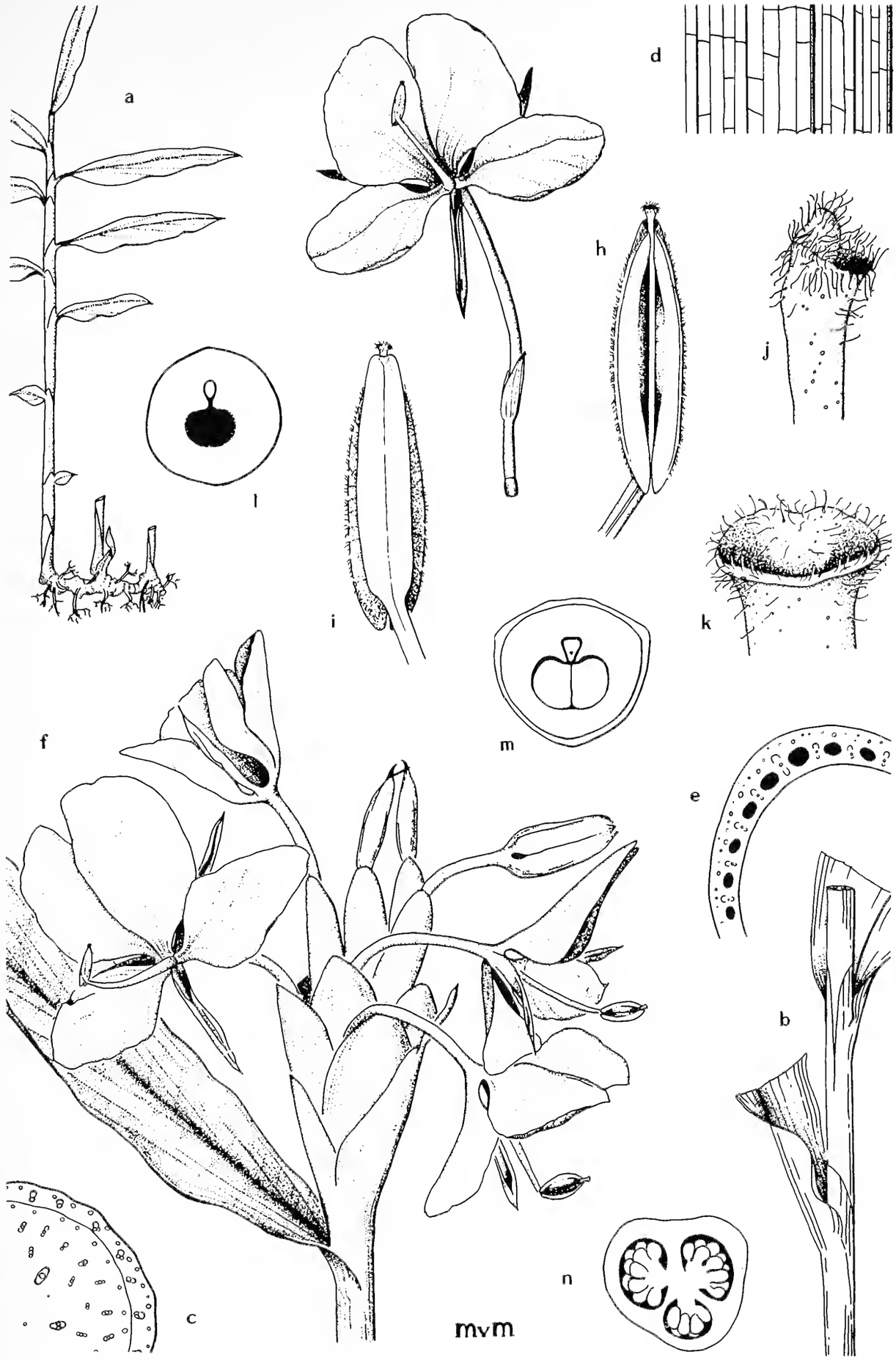
One of the marks of greatness in a biologist is his ability to appreciate, and foster links between, his own research and research at other organizational levels. In biology, this is as true of organismic biology as of other levels, and good systematists have always taken pride in their abilities as synthesizers. Fortunately, the boundary between systematics and other biological disciplines is becoming intellectually less clearly demarcated. The gulf that arose between the observational and the experimental sciences, and research at organismic, cellular, and lower levels of biological organization, has been severely detrimental. The rise of ecology, as both an observational and an experimental discipline, has helped bridge the gap in some universities. In Harvard, bridges are being built through comparative functional morphology and anatomy, and through ecological physiology.

Our living collections, which are probably the most completely documented of their kind in existence, are a superb tool for research and instruction in the comparative biology of the whole plant. They provide the practical means to link systematics with comparative, descriptive, and experimental studies in morphology, anatomy, and

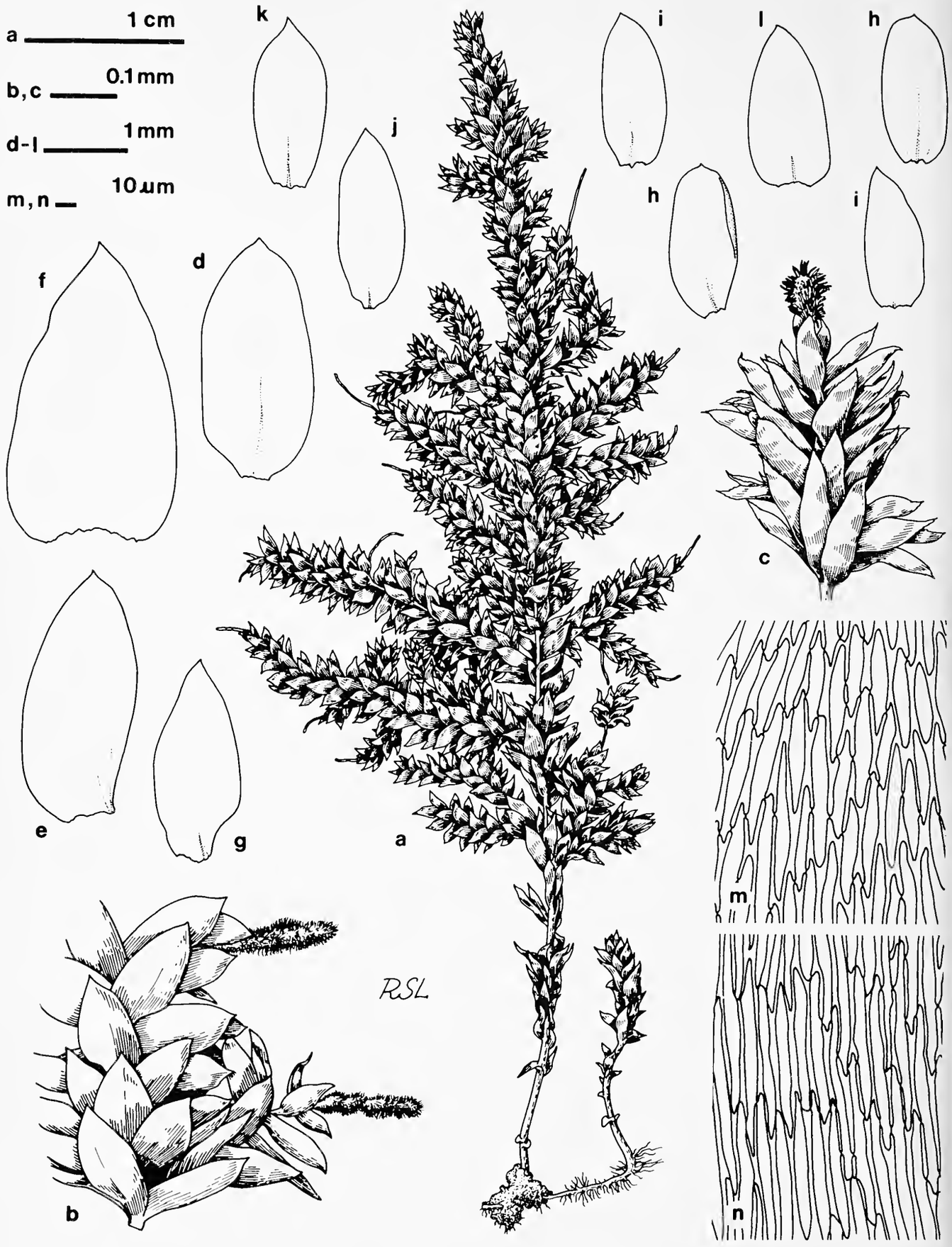
ontogeny, with reproductive biology, embryology, cytology, and genetics, as well as physiological ecology.

Nowhere is the need for an integrated approach more urgent than in biological research in the tropics. The great majority of organisms on earth are tropical. It has been calculated that, of the 240,000 species of flowering plants, 155,000, or some 65 percent, are tropical. Among woody plants, there are approximately 20 times more species in the tropics than in the rest of the world. Many whole families of plants are confined to the tropics, as are many manifestations of plant form. In the favorable climate of the aseasonal and humid tropics, plant species richness (and that of some animals, notably insects) reaches its zenith. In this exceptionally uniform environment the determinants of natural selection appear to be largely biotic and frequently are extremely intricate. Many of the leading problems in comparative and evolutionary biology must, therefore, be addressed in the tropical rain forests. However, present rates of tropical deforestation, which are estimated to be 200,000–250,000 km^2 annually, suggest that within 50 years these forests will be reduced to modified fragments, no longer suitable for answering many of these questions. Nor is this dilemma merely academic: as much as half the world's flora may be extinguished during this time, during a period when increasing energy costs will necessitate dramatic changes in industry and agriculture, requiring new crops and more intensive use of renewable resources. Without expanded research in tropical botany, many species of potential economic value in agriculture and forestry, and others which may yield new chemicals for the pharmaceutical and other industries, will be lost before their importance is realized.

The tree flora of the Far East is the richest on earth. The Arnold Arboretum, as repository for the most extensive herbarium collections and library for the study of the botany of tropical Asia in this country, must play a leading part in advancing this research while time remains. High priority must again be given by our institution, as custodian of the necessary resources, to monographic systematic research for, as mentioned, this will provide the critical base from which hypotheses can be formulated, and assure a stable nomenclature. There is, however, an immediate practical need for local floras, of which Dr. Richard Howard's current *Flora of the Lesser Antilles* serves as a fine example. Increased collection of plant specimens, particularly from our area of specialization in Asia, is essential for our future research and is a responsibility which, in view of our existing strengths, we owe to the biological community as a whole. Particular emphasis needs now to be placed on those several regions which remain little collected, yet where deforestation is now rapid; on novel collecting methods enabling preservation of anatomical, including embryological, material, and ideally, the creation of DNA or clone banks of species of particular interest; and on the total inventory of restricted areas of selected plant communities.



The illustration above shows structural and biological details of Hedychium coronarium, *a member of the ginger family (Zingiberaceae) from southeastern Asia that is widely cultivated and naturalized in the tropics. Prepared by Margaret van Montfrans, who joined the staff this year as a botanical illustrator, this is one of the illustrations for the "Generic Flora of the Southeastern United States," a long-term project that involves some 190 families and almost 1300 genera of seed-bearing plants of nine Southeastern States. The project is currently supported by a three-year grant from the National Science Foundation with C. E. Wood, Jr., and N. G. Miller as principal investigators.*



Drawings of the moss Trachyloma diversinerve *by Robin S. Lefberg, a botanical illustrator at the Arnold Arboretum from 1975 to 1978. This plate accompanies a monograph of* Trachyloma *finished during the year by Norton G. Miller in collaboration with the late Monte G. Manuel of the University of Malaya.* Trachyloma diversinerve *is found in eastern Australia, New Zealand and New Caledonia. Especially noteworthy are its clusters of filamentous gemmae produced at the tips of branches (see b & c).*

The reader may wonder why no mention has been made of horticultural research, for which the Arnold Arboretum has a distinguished reputation. Several of those aspects of basic scientific research, for which our living collections can provide such valuable material, are also basic to horticulture: systematic and comparative morphology and anatomy provide the descriptive framework, and embryology, cytology, and genetics the groundwork, for propagation and plant breeding. Horticultural needs provide an additional reason for the broad research policy outlined here.

In the past, our institution had on its staff botanists such as Alfred Rehder, and horticulturalists such as Donald Wyman, who prepared the encyclopedias of cultivated woody plants upon which we still rely. The need now, with so many plant species known, with nomenclature as well as taxonomic confusion in many major taxa, and with the almost limitless multiplication of cultivars, is once again for thorough monographic treatment of the major woody plant taxa in cultivation. In temperate Asia there still remains a need for exploration in the quest for new taxa and, more particularly, for hardier genotypes than are currently in cultivation. It is to these ends that the research of Dr. Stephen Spongberg and Dr. Richard Weaver is dedicated.

At the same time, our living collections staff are encouraged, and indeed expected, to pursue research in propagation, in hardiness testing, and in assessment for horticultural display, thus continuing the traditions established by Jackson Dawson, Alfred Fordham, and others in the past. The results will continue to appear in the pages of our horticultural journal, *Arnoldia*.

It is obvious that the endowment of the Arnold Arboretum is inadequate to support research in every aspect of whole plant biology or, indeed, in more than a few of the fields advocated in this report. Future appointments must take into consideration the need for continued strength in monographic systematic research, so that our collections may continue to be available to the wider scientific community. Future appointments must equally encourage as broad a use of our collections, and in particular our living collections, for research and instruction as they can sustain.

Systematic research proceeds through gradual, consistent accumulation of experience gained by continued use of biological collections. The collections, in turn, require constant, meticulous curation by scholars of the highest caliber. It is for these reasons that the Arnold Arboretum must continue to maintain a strong representation of systematic botanists on its staff. Furthermore, our obligations to the international scientific community, in the development of our collections and in systematic research, will be dependent on the grant support which our tenured staff alone can command.

Systematics requires, at one and the same time, a broad appreciation of the biology of the whole organism, meticulous care for detail, and an awareness of how to analyze the resulting data in a variety of

ways useful to scientists with differing requirements. Our most intractable dilemma is the current dearth of plant systematists who have the breadth necessary to build from plant taxonomy to general biological theory. Contemporary attitudes in education have militated against this approach to biological endeavor, as one may observe in the remarkable naiveté of some of our new graduate students. Harvard is now possibly alone in providing the necessary combination of breadth and detail required of good systematists and, I would argue, in any *whole* biologist, and this is reflected in the continued demand for our graduates by the nation's colleges and museums.

Systematics cannot survive in isolation, but our future appointments policy can be a powerful integrating force. The living collections of the Arnold Arboretum make us particularly well-placed to foster the consolidation of whole plant science at Harvard, by ensuring that the collections are maintained and kept available to our scientific community as a whole, and through appointment of both descriptive and experimental scientists in fields which can benefit from the resources that our institution possesses. Our pending appointment in the field of root biology is being made in this spirit. It is to be hoped that our income will allow similar future appointments, though it is clear that they cannot be made to the detriment of our continued strength in systematics.

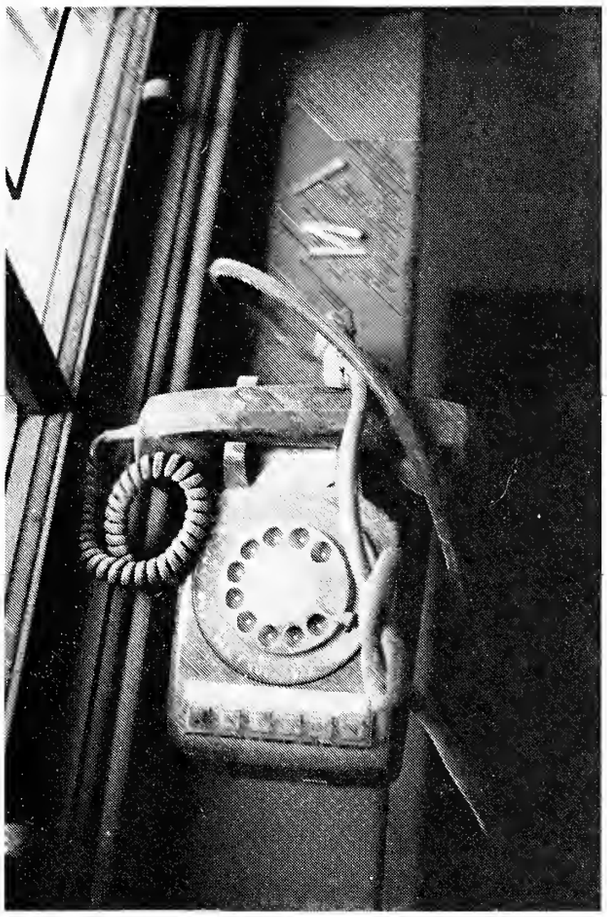
Harvard must seize the opportunity to continue the distinctive tradition in biology that its institutions have made possible. Our new Department of Organismic and Evolutionary Biology, made up almost entirely by staff of the affiliated institutions, can thus advance biological knowledge, and instruct students, through as comprehensive an approach as that provided by any university. In the realm of tree biology, future staff of the Arnold Arboretum should be contributing to all levels, from the broad systematic monograph to the experimental investigation of individual phenomena.

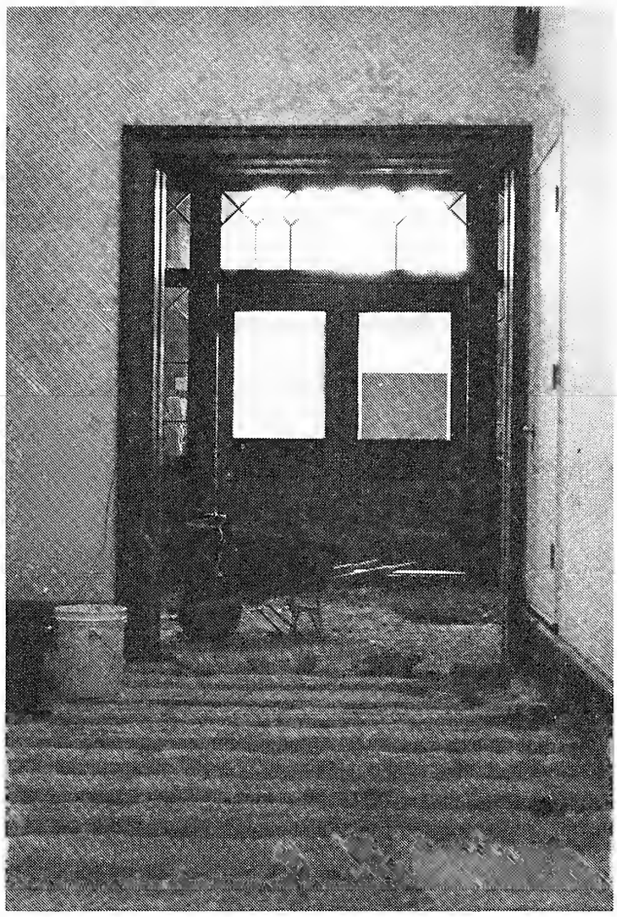
ORGANIZATION

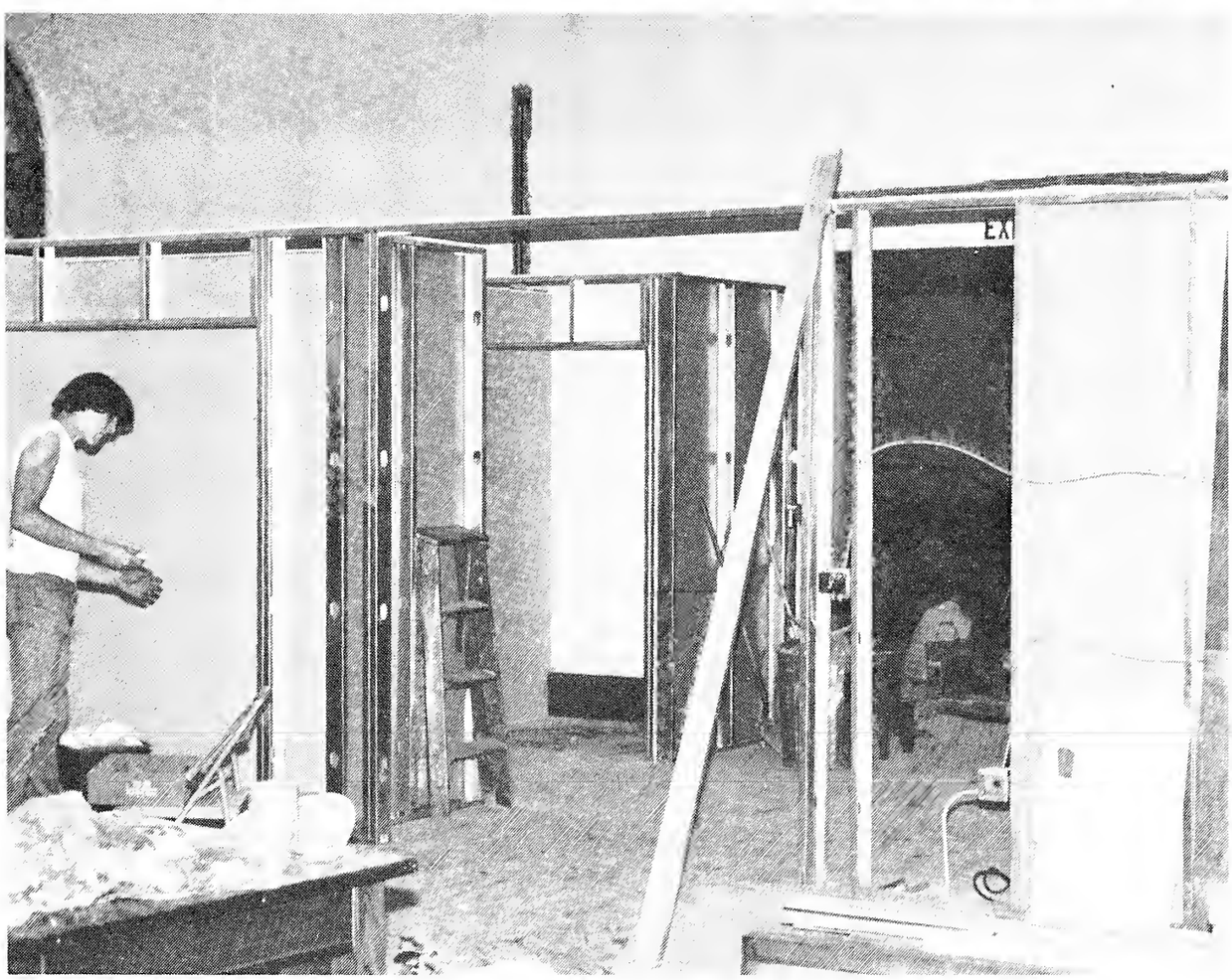
Mr. Franklyn Stevens was appointed office manager in September, 1980. Mr. Stevens has been responsible for some major improvements in the organizational infrastructure and financial systems of the Arnold Arboretum.

Upgrading of the telephone system in Jamaica Plain, and installation of postage machines in Cambridge and Jamaica Plain, are affording further cost and time savings. Steps are being taken to utilize automated billing, available through Harvard's Accounts Receivable Department, for subscriptions to our two journals.

Renovation and reorganization of the interior of the Hunnewell Administration Building in Jamaica Plain, which was coordinated by Ms. Wendy Marks, the manager of public services, will receive mention in several parts of this report. A new energy-efficient heating







The first phase of the Hunnewell Building renovation meant tearing out floors and walls. The result will bring new and improved public facilities to the Arboretum, including a lecture room and, for the first time, public rest rooms.

system was installed. The former herbarium space at the back of the first floor was converted into office space for the secretarial staff, the director, the manager of public services, and living collections staff; a reception room and booths for handling plant information inquiries were also provided. The first floor contents of the herbarium have been moved up to the fourth floor and air conditioned. The second floor materials remain in place, but the clerestory opening in the center of the floor has been cemented in, and a separate office provided for the herbarium preparators. The front of the building on the first floor is being converted to space for the public program. The former first-floor library has, therefore, been moved to the third floor at the back of the building, bringing it to the same level of, and allowing integration with, the rest of the library in the building. Both library and herbarium are now taken out of direct public access, thereby improving conditions for conservation and security. The daunting tasks of moving the library and herbarium were coordinated by Horticultural Research Archivist Sheila Geary and Staff Assistant Ida Hay, respectively.

Miss Dorothea Talbot, secretary to the director, retired during the year; she was replaced by Ms. Susan Bryant.

RESEARCH AND INSTRUCTION

Highlights of the year's research included the publication of Dr. Peter Stevens's monograph of the Old World species of the tropical, mainly Far Eastern tree genus *Calophyllum* in the *Journal of the Arnold Arboretum.* This is one of the few truly comprehensive contemporary studies of any of the very large and taxonomically complex tropical flowering plant genera that are of such interest to the evolutionary biologist. Dr. Stevens's treatment lays a secure groundwork that should stand the test of time. It describes in critical detail the patterns of variation from which hypotheses concerning speciation can be derived and tested, and at the same time it provides the forester with the tool by which he may identify the species in the field.

In addition, the year witnessed an upsurge of interest in the living collections for research. The work that has been undertaken is remarkable for its diversity: systematic research has continued in Rosaceae, Theaceae, and *Viburnum;* an important publication of Dr. Howard's anatomical research appeared; there have been mathematical studies of variation in leaf shape in *Acer,* and research on the branching patterns and tree architecture in *Viburnum, Tsuga,* and *Asimina;* cytogenetic studies proceeded in Hamamelidaceae and Platanaceae; the breeding system of *Ulmus* was investigated; there were attempts to induce cone formation and flowering in selected gymnosperms and angiosperms by application of growth hormones; *Magnolia virginiana* was found to possess an unusual pattern of embryo development and seed germination; and a comparative study of *Alnus* species that fix nitrogen in the roots has been initiated, with the eventual aim of assessing them as a source of cattle forage. The

imminent appointment of a professor in root biology, and the receipt of a gift towards the acquisition of equipment to set up a laboratory in chemosytematics in Jamaica Plain, will further strengthen research using the living collections.

The resurgence of interest in the botany of China continued this past year. Dr. Stephen Spongberg accompanied four botanical colleagues on the first Sino-American expedition since the Chinese Revolution, and Dr. Shiu-ying Hu made an extensive lecture tour of China.

Professor Peter Ashton concentrated on studying and annotating the collections of Dipterocarpaceae at two major Far Eastern herbaria. The combined holdings in the National Botanic Gardens and Forest Research Institute in Bogor, Indonesia, comprise more than 40,000 numbers. Dr. Ashton visited these institutions in June and July, 1980, and during the following winter continued with the work using materials sent on loan. Work on the Forest Research Institute collection is now completed. While in the Far East, Dr. Ashton attended the Second Round-Table Symposium on Dipterocarp Research in Kuala Lumpur, Malaysia, where he presented a paper and chaired a session. Thereafter he attended a symposium at Cambridge University, Biological Aspects of Rare Plant Conservation, where he also presented a paper. He lectured at Yale University at the School of Forestry and Environmental Studies and again at the Department of Biological Sciences. He also lectured to biology students at Lehman College, New York, and to horticulture students as part of the University of Delaware's Longwood Program. He served on a panel at a planning conference organized by the president of the New York Botanical Garden, and on another convened at Tufts University to discuss the conservation of genetic resources. A chapter on the forests of tropical Asia, for a book on the current status of tropical forests, was submitted.

During the year, Paul Cox, who was advised by Dr. Otto Solbrig and Dr. Ashton, submitted his thesis, entitled "Pollination and Unisexuality in *Freycinetia*." Mr. Steven Rogstad and Mr. Paul Rich are also advised by Dr. Ashton, the latter in collaboration with Dr. Thomas Givnish. Dr. Richard Primack continued his field work in East Malaysia, on a grant awarded Drs. Ashton and Stevens by the U.S. Department of Agriculture, Forest Service. He is studying the wild breadfruits (*Artocarpus*) and tree figs (*Ficus*) of that region, which is the center of their species diversity. A field manual, for which illustrations are under preparation, has been otherwise completed, and Dr. Primack is now concentrating on growth and demographic studies of selected species.

Professor Richard Howard continues his work towards the treatment of the Dicotyledoneae for the next volume of the *Flora of the Lesser Antilles,* for which some illustrations have also been prepared. With permission from the Linnean Society of London, which owns the manuscript, he has completed a transcription of Alexander Anderson's early nineteenth century accounts of the geography and history

of the island of St. Vincent, and of the history of its botanical garden, which is the oldest in the New World. In collaboration with other specialists, he is attempting to interpret the plant description in Anderson's manuscript "Hortus." Dr. Howard also completed a paper on William Hamilton and his *Prodromus Plantarum Indiae Occidentalis;* two papers on *Opuntia* (Cactaceae) in the Lesser Antilles; one on the stay in Boston of Olaf Swartz, a student of Linnaeus who conducted plant explorations in the Lesser Antilles; one on Solander's *Florula Indiae Occidentalis;* another relating to Louise O'Farrell's plant paintings from St. Croix; and also a manuscript, entitled "Additional Notes on *Coccoloba* in Jamaica," to be included in a more extensive revisionary paper by Dr. George Proctor. Treatments of Icacinaceae and Polygonaceae are currently under way for the floras of Venezuela and of Nicaragua. Dr. Howard, who holds a National Science Foundation grant for his research towards a *Flora of the Lesser Antilles,* was awarded a grant from the Stanley Smith Horticultural Trust for work on the Anderson manuscripts.

Dr. Howard received the Award of Merit for 1981 from the Montserrat, West Indies, National Trust. He attended the organizational meeting of *Flora Neotropica* in Quito, Ecuador, visited herbaria there and in Lima, and did some collecting; he serves on the Editorial Committee of the *Flora.* He chaired an ad hoc committee for the dean of the Graduate School, University of Michigan, for evaluation of the Matthaei Botanical Garden and attended a meeting of the Plant Collections Committee of the Pacific Tropical Botanical Garden during its board meeting in Boston. Dr. Howard identified collections of cultivated plants of the Scientific and Industrial Research Organization of Pakistan and the Agriculture Department of New Caledonia, as well as the holdings of Polygonaceae and Icacinaceae for the French Organization for Overseas Scientific and Technological Research (ORSTOM) at Cayenne. He lectured at the University of Connecticut and gave a botany seminar at Harvard, as well as a talk to the graduate students' Society for Expeditionary Biology.

Dr. Shiu-ying Hu, who is retired, continued indefatigably in her studies of the botany of China. Between September, 1980, and February, 1981, she was in the Far East. After attending the Third International Ginseng Symposium in Seoul, Korea, where she presented an invited paper, she continued to Bangkok. There she presented papers on Chinese materia medica at the Fourth Asian Symposium on Medicinal Plants and Spices sponsored by the World Health Organization, and at a Thai-U.S. Cooperative Symposium on Underexploited Economic Plants. Thereafter she was in China, where she ran short courses in plant taxonomy at fourteen colleges and universities throughout the country and spoke at branches of the Botanical Society of China and at horticultural clubs. As an invited participant, she also attended a review meeting of the Executive Board of the Botanical Society in Canton. For over a quarter century, senior Chinese botanists have been unable to communicate with colleagues in other

Above: *Shiu-ying Hu lecturing in the South China College of Agriculture in January, 1981.*
Below: *Dr. Hu with Chinese botanists from various organizations in the four northeastern provinces of China. Her series of lectures was organized by, and took place in, the Chinese Institute of Forestry, Harbin, Heilungjiang, from November 7 through November 12, 1980. The president of the Institute, Professor C. Y. Yang, is China's leading specialist on Lauraceae. He was a good friend of the late Professor E. D. Merrill, and visited the Arnold Arboretum when Merrill was director.*

Dr. Steven Spongberg participated in six weeks of field work in the Shennongjia Forest District of western Hubei Province, in the Shennongjia Mountains. Over 2,000 collections were processed comprising in excess of 25,000 herbarium sheets. Pictured below are Chinese members of the expedition preparing the specimens.

countries. They are anxious to hear of the current issues in science outside of China and to train younger colleagues for senior positions. Dr. Hu, now in her seventies, covered 14,000 miles within her native country, daily giving courses and holding discussions between 8:30 in the morning and 5:30 in the evening. This remarkable effort was clearly much appreciated and very much reflects the new spirit of cooperation which the Arnold Arboretum wishes to develop with its Chinese colleagues.

Dr. Stephen Spongberg also concentrated this year on reestablishing both the Arboretum's cooperative program with Chinese botanists and its long-standing interest in the flora of China. These activities were facilitated through his participation as the Arnold Arboretum representative in the 1980 Sino-American Botanical Expedition to Western Hubei (Hupeh) Province. The expedition took place between August 10 and November 16, 1980. Sponsored under the joint auspices of the Academia Sinica and the Botanical Society of America, the expedition involved three months of field work in the Shennongjia Forest District and the *Metasequoia* region of Lichuan Xian (Hsien) in western Hubei Province, as well as travel to botanical institutions and gardens throughout China. Financial assistance was provided by a grant from the National Geographic Society and by a special fund established by the American Association of Botanical Gardens and Arboreta. While in China the American team was hosted by the Institute of Botany, Beijing (Peking), and the Wuhan Institute of Botany, Hubei, both of the Academia Sinica, and their field work was greatly assisted through the kindness of local provincial government officials. Professor Sun Siang-chung, director of the Wuhan Institute of Botany and chairman of the Department of Biology of Wuhan University, was the leader of the expedition, which was joined in the field by botanical colleagues from five botanical institutions elsewhere in China. The scientific results of the expedition, which are currently being prepared, will be published in a joint report in the *Journal of the Arnold Arboretum.* Dr. Spongberg will serve as general editor. Together with Dr. David Boufford, of the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, he has also had the primary responsibility for identifying the 2,085 herbarium collections gathered during the expedition. Dr. Boufford spent six weeks at the Arboretum during February and March to assist in this project. Altogether, these collections represent about 25,000 herbarium sheets, which were divided equally between the Chinese and American teams.

While in western Hubei, Dr. Spongberg was also able to observe and make herbarium and seed collections, as well as dried leaf collections for chromatographic analysis, of several taxa of *Sorbus.* Opportunities to work in several Chinese herbaria also allowed him to continue his study of *Sorbus, Hartia, Stewartia,* and genera of the Magnoliaceae.

In addition, Dr. Spongberg has begun sorting through W. P. Fang's Mt. Omei and Szechuan collections that have been stored in Merrill

boxes in Jamaica Plain for 30 years or more. These specimens are gradually being mounted.

Dr. Spongberg still found time to continue his responsibilities as editor of the *Journal of the Arnold Arboretum* and, with the valued collaboration of Dr. Howard, to add some 750 citations to the Rehder card index, the comprehensive bibliography for cultivated woody plants.

Professor Peter Steven's monograph of Old World *Calophyllum* appeared in the *Journal* early this year. He has since made a start on *Mesua,* the second largest genus in the subfamily Calophylloideae of the important tropical family Clusiaceae. Initial studies are bringing to light a number of interesting characters from all parts of the plant, many of which have not been observed or have been ignored for a century, but the variation pattern promises to be yet more complex than in *Calophyllum.* Field work undoubtedly will be needed to further its comprehension. With students Mr. Paul Groff and Mr. Michael Donoghue, Dr. Stevens has been preparing a critique on the current uncritical use of morphological terminology, with a view to indicating its potential for misguiding observation and theory. Arising from his new course on the history of botanical systematics, Dr. Stevens is preparing a paper on the interrelationship between the sciences of crystallography and botanical systematics between 1740–1840. A more general study of the metaphors used to describe the relationship in natural systems in immediately pre-Darwinian times is also under way. Dr. Stevens completed a critical evaluation of the criteria used to determine whether characters are advanced or primitive, concluding that most are highly suspect and lead to circularity in argument.

Dr. Stevens continues to supervise graduate students Ms. Elizabeth Taylor and, with Professor Richard Schultes, Mr. Jeffrey Hart; he also has become an advisor of Mr. Brent Mishler. He gave invited lectures at the University of Western Ontario, Guelph University, and Tufts University.

Dr. Stevens has continued his active curation of the herbaria and has identified material received from Thailand, India, and the Pacific. Also, with assistance from graduate students, he named a number of unidentified plants from Central and South America.

Professor Carroll Wood, in collaboration with Dr. Norton Miller, assembled a grant proposal for continuation of the *Generic Flora of the Southeastern United States,* in which they plan to work as co-principal investigators. The National Science Foundation has made a substantial three-year grant for this monumental project which, if continuously funded, is expected to be completed within the next decade. The account of Amaranthaceae, by a former Arboretum assistant curator, Dr. Kenneth Robertson, will appear in the *Journal* in July, while a former student, Dr. Christopher Campbell, now of Rutgers University, is starting a treatment of the tribes of Gramineae in the Southeast.

Dr. Wood has received grants for each of his graduate students for field work, initially from the Atkins or Anderson funds of the University, and subsequently from the National Science Foundation Program for Doctoral Dissertation Research in Systematic Botany. Ms. Elizabeth Coombs, who was thereby enabled to visit the western states last year, traveled to the Gaspé Peninsula in Quebec, and again to the Sierra Nevada of California in late summer, 1980, in order to pursue her studies in the *Poa sandbergii* complex of bluegrasses. Mr. Brent Mishler, who is supervised by Drs. Miller, Wood, and Stevens, is enabled through one of these grants to pursue his systematic studies in the moss genus *Tortula* (Musci/Pottiaceae) in the southwestern United States and, later, in Mexico. He has meanwhile prepared a treatment of the genus for the forthcoming moss flora of Mexico. Dr. Wood has taken part in a Genetics Training Grant awarded to the Department of Biology that has assisted in the field work of Ms. Coombs and Mr. Mishler, of Mr. Donoghue whose thesis is now near completion, and also that of Dr. Campbell, who received his degree last year and is now teaching at Rutgers University. With its help, Ms. Coombs and Mr. Donoghue attended a workshop on the theory and application of cladistic methodology at the University of California in March, 1981.

Dr. Norton Miller, botanist, meanwhile continued his research on Pleistocene macrofossils. He analyzed a stratigraphic suite of fossil mosses from sediments of Upper South Branch Pond, Maine, as part of a collaborative effort on the vegetational history of north-central Maine with Dr. Ronald Davis and Mr. R. Scott Anderson of the University of Maine. He also identified an assemblage of moss and other plant macrofossils from late glacial sediments from a kettle hole near Brampton, Ontario. These materials were provided by Dr. Alan Morgan of the University of Waterloo. Samples containing an assemblage of mosses were sent for study by Dr. James King of the Illinois State Museum in Springfield. The fossils are from a late Wisconsonian interstadial deposit in Illinois. The floristic composition of the assemblage, which was discovered during excavation associated with the installation of a nuclear power plant, is similar to an assemblage studied a few years ago from the Gardena locality in Illinois and also presumably the same age, although a C-14 age determination is pending. Both assemblages indicate the existence of rich fens. One contains fossils of the moss *Cinclidium latifolium*, currently a species of the North American High Arctic and thus potentially an important paleoecological indicator. Work on *Cinclidium* has been pursued with Dr. Gert Mogensen of the Botanical Museum, University of Copenhagen, an authority on the genus. Study of plant fossils, mostly mosses, from a deposit of till deduced on stratigraphic grounds to be of early Illinoian age has been completed in collaboration with Mr. Stephen Jackson of Indiana University.

During the first two weeks of April, Dr. Miller was joined by the late Dr. Monte Manuel of the University of Malaya. They finished the taxonomic part of a joint monograph of the Australasian-Oceanian

moss *Trachyloma* (Pterobryaceae). The scanning electron microscope was extensively used for examination of calyptrae, peristomes, and spores. Plates illustrating most of the species and varieties have been assembled, and a manuscript is being assembled for publication. Two short floristic notes, "*Loeskypnum wiskesiae* (Musci: Amblystegiaceae) in Alaska," prepared with Dr. Zennoske Iwatsuki of the Hattori Botanical Laboratory, Japan, and "*Grimmia anodon* (Musci: Grimmiaceae) in North America north of Mexico," jointly with Dr. Robert Ireland of the National Museums of Canada, have been submitted for publication. Lastly, work has begun on a chapter treating Cenozoic Bryophyta for a new edition of the *Manual of Bryology*. This book, which will update the current manual by Dr. Frans Verdoorn (1932), is being organized by Dr. Rudolph Schuster of the University of Massachusetts.

Dr. Miller gave invited lectures at the Department of Earth Sciences, University of Waterloo, Canada, and at the University of Alberta, Edmonton. He attended the Sixth Biennial Conference of the American Quaternary Association at the University of Maine, Orono, and the Annual Meeting of the American Bryological and Lichenological Society which was held at the Highlands Biological Station, North Carolina. Dr. Miller was elected to the Council of the Society and has been appointed to a two-year term as the associate editor of *The Bryologist*.

This year Dr. Bernice Schubert saw the publication of two papers on which she had been working for some time: a treatment of *Desmodium* (Leguminosae) for the *Flora of Panama* and, with Dr. Hiroyoshi Ohashi and Dr. Roger Polhill, a paper on the whole tribe Desmodieae, which includes twenty-seven genera in three subtribes. She is currently attempting to clarify the *Desmodium intortum–D. uncinatum* group of species, which are widespread in the New World tropics. The two species after which the group is named have recognized potential as agricultural forage crops. Botanical artist Ms. Margaret van Montfrans, who joined the Arnold Arboretum in February, 1981, is preparing illustrations for this study. Scanning electron microscope studies of the pollen of another difficult group, *Desmodium* subgenus *Nephromeria,* mainly vines, has begun. Dr. Schubert is also committed to preparing a treatment of *Desmodium* for the *Revised Flora of Ceylon,* and another treatment of the genus for a new project on the Leguminosae of Oaxaca, Mexico.

Dioscorea, another long-standing interest of Dr. Schubert, is a large, diverse, and systematically very interesting genus still requiring much study. The organization of the *Dioscorea* material of Dr. Temple Clayton, alluded to in my last annual report, continued this year. A number of *Dioscorea* collections loaned for determination were identified. Dr. Schubert has agreed to prepare treatments of Dioscoreaceae for Dr. Wood's *Generic Flora of the Southeastern United States,* for the *Vascular Flora of the Southeastern United States* being published by the University of North Carolina, and for two Mexican regional floras.

In the large genus *Begonia,* Dr. Schubert has confined her attention to New World species. This year she has concentrated on *Begonia extensa,* for which complete material has recently become available for the first time. She will be preparing the treatment for the *Generic Flora of the Southeastern United States* and hopes also to prepare a revision of the Colombian species, on which she has published previously (with Dr. Lyman Smith, in Contrib. Gray Herb. 164, 1946). She gave a talk on sections of the genus *Begonia* to the Buxton branch of the American Begonia Society.

We have welcomed two long-term visitors to the herbarium this year. Dr. George Proctor of the Institute of Jamaica has been undertaking revisionary research on the flora of Jamaica with support from the Atkins Fund of Harvard University. Thus far, he has revised and completed an illustrated *Flora of the Cayman Islands,* and a paper, "Additions to the Flora of Jamaica," intended to be a supplement to C. D. Adams's *Flowering Plants of Jamaica* (1972). Work is in progress on a volume dealing with the ferns of Jamaica of which there are over 600 taxa. Two short papers have been published and appear in the bibliography. Dr. Benjamin Stone of the University of Malaya, who spent from March to July, 1981, with us as a Mercer Fellow, pursued two projects. He continued his monographic research into Pandanaceae, the screw pines. He was able to complete a revision of *Pandanus* subgenus *Rykia* and to accumulate materials for revision of several other subgenera and for the genus *Freycinetia.* He prepared regional treatments of *Pandanus* for Indochina and, in brief, for Sumatra. He also completed a revision of the difficult genus *Glycosmis* (Rutaceae, Aurantioideae) and prepared materials for other genera in its group. In all, Dr. Stone completed six manuscripts for publication, fully curated our Pandanaceae holdings, and partially curated our Asiatic Rutaceae. The numerous type collections in our herbarium proved of crucial value to his research, as did our comprehensive holdings of botanical literature pertinent to the botany of Asia and the Pacific.

Among our living-collections staff, Mr. Peter Del Tredici completed and published a study of the embryo development and germination characteristics of *Magnolia virginiana* and continued his work on the growth and branching pattern of *Tsuga canadensis* and its cultivars. Dr. Richard Weaver, who was fully committed to curatorial and restoration work in the living collections this year, provided taxonomic assistance to an undergraduate, Mr. William Buikema, who was pursuing palynological and cytological investigation of *Corylopsis* (Hamamelidaceae) with advice from Dr. Alice Tryon.

I have summarized the range of research activities being undertaken through use of the living collections of the Arnold Arboretum in the introduction. Among these, several have received mention in previous reports. Mercer Fellow Dr. Amar Hans completed his study of *Ulmus* breeding systems in July, 1980, and returned to Lusaka. Dr. Hans, who is the senior forest geneticist at the Forest Research Insti-

tute of the Government of Zambia, came to the Arnold Arboretum to gain experience in breeding work with hardwood trees prior to initiating fruit tree improvement in his own country. Dr. Alan Longman of the United Kingdom Natural Environment Research Council Institute of Terrestrial Ecology Station at Penicuick, Midlothian, Scotland, visited the Arboretum with his technician, Ms. Jan Dick, in the spring of 1981. With the collaboration of Mr. Del Tredici, branches of over twenty different recalcitrant-flowering tree species were either bark-ringed or injected with varying concentrations of gibberellic acid in an attempt to induce flowers or cones. The earliest results will not be known until 1982.

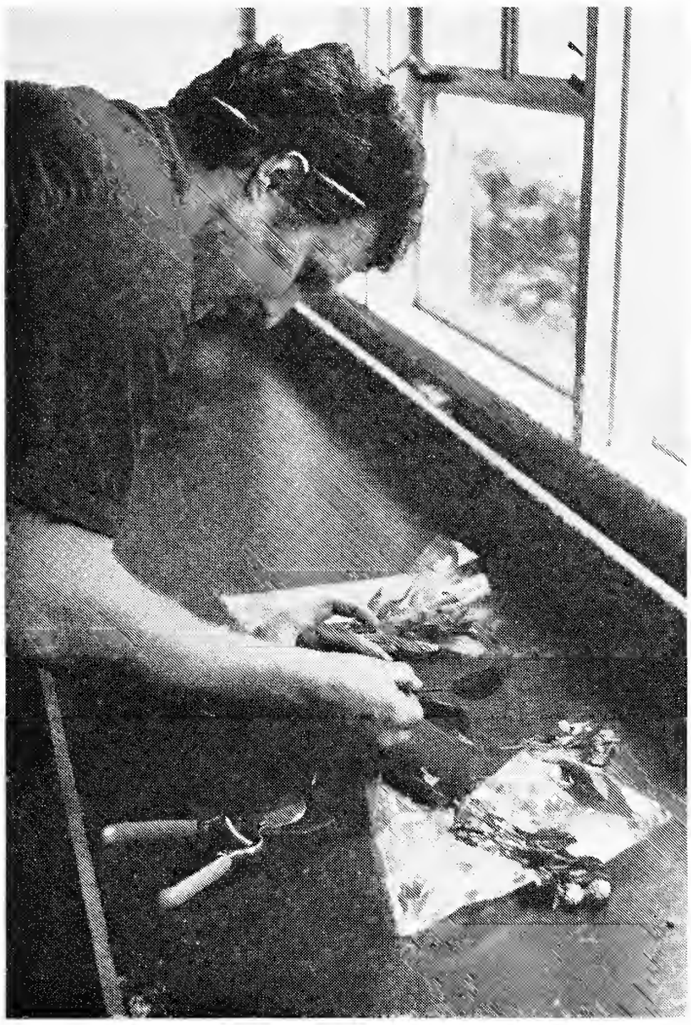
Mr. Geoffrey Nolin, a student at Hampshire College, was awarded a grant by the Percy Selden Fund to spend a year at the Arboretum. Mr. Nolin has been pursuing a project on nitrogen fixation in *Alnus* under the supervision of Dr. John Torrey of the Harvard Forest. He is now extending this work to the collection, propagation, and evaluation of two genera, *Alnus* and *Ceanothus*. Both genera fix nitrogen in association with actinomycetes in their roots. *Alnus* foliage is known to be rich in protein and has potential as a forage for cattle.

Research using the living collections of the Arnold Arboretum will be substantially strengthened thanks to a generous anonymous benefactor who has provided us with the means to equip a chemosystematics laboratory in the greenhouse/headhouse in Jamaica Plain. Initially it is intended that research will be conducted in collaboration with Drs. Gillian Cooper-Driver and Tony Swain of Boston University. It is also likely that our root biologist, once appointed, whose laboratory will be in the same building, will share some of the facilities.

All professorial staff with graduate students under their supervision offered 300-level courses during the academic year. Dr. Stevens, with Professor William Fink, continued to run the Systematics and Biogeography Group, which had its fourth season. The discussion group, which provides an informal forum for systematics as a whole, meets fortnightly. The general standard of discussion this year was very high, and meetings were well attended. The Museum of Comparative Zoology funds the group jointly with the Arnold Arboretum.

All professorial staff of the Arboretum also contributed to undergraduate instruction this year. Professor Ashton collaborated with Professors Thomas Givnish and Kenneth Sebens in Biology 250, "Tropical Ecology," in the fall term. This course provides an introduction to the ecology of tropical communities, with particular emphasis on plant adaptations and their effect on species distributions and abundances. Following the course, a field trip was organized to Venezuela. Professor Ashton, with Professor Barry Tomlinson of Harvard Forest, taught for two weeks in Costa Rica in February as part of the Organization of Tropical Studies graduate course program.

Professor Howard collaborated with Professor Tomlinson in the summer course in tropical botany, S-105, during June and July, 1981,



At the greenhouse, Geoff Nolin (left), *working on an independent research project with cuttings of* Alnus glutinosa. *His aim is to develop and standardize propagation procedures for the genus* Alnus. Below: *Volunteers repotting young plants with the characteristic enthusiasm that makes them such a valuable asset to the Arboretum.*

at the Fairchild Tropical Garden, Miami. Dr. Howard was guest lecturer on poisonous plants in Dr. Schultes's course, Biology 104, "Plants and Human Affairs," in the spring term. Dr. Howard also supervised Biology 91r, undergraduate research, for Ms. Mia Touw, who compiled a special report entitled "Asa Gray and the Wilkes Expedition — Lobeliaceae" and Biology 98r, undergraduate honors research, for the same student, in this case involving preparation of a thesis on Tibetan materia medica.

In the fall Professor Stevens collaborated with Professor Fink in Biology 148, "Systematic Biology." In the spring he offered a new course, Biology 164, "History of Botanical Systematics." This course dealt with the development of systematics from pre-literate societies to the beginning of the twentieth century. The emphasis was on the comparison of practice and theory in systematics, with the aims both of being better able to understand the work of the early systematists, much of which is still being used, and also to appreciate the degree to which they were able to reach their avowed goals. It is important to understand this, since much current systematic practice was developed as long ago as the first part of the nineteenth century.

Professor Wood, with Professors Tomlinson and Pfister, taught Biology 18, "Diversity in the Plant Kingdom," in the fall as usual. Graduate students Ms. Elizabeth Taylor and Mr. Calvin Sperling acted as teaching fellows. Dr. Wood's Biology 103, "The Taxonomy of Seed-Bearing Plants," was taught in the spring. The ratings of the latter remain as high as ever; student teaching fellow Mr. Michael Donoghue received special commendation.

In February Professor Wood was one of the panelists in the professional training series of the Harvard-Danforth Center for Teaching and Learning. This session was devoted to lecturing in the sciences, in this instance biology.

Dr. Wood made extensive use of materials collected and preserved from the living collections for teaching Biology 103 during the winter months. Field classes were conducted in the living collections for Biology 18 and Biology 103. The following universities and colleges, besides Harvard, currently use the living collections for instruction: Bentley College, Boston College, Boston University, Fisher Junior College, Northeastern University, Simmons College, Smith College, Springfield Technical Community College, State University of New York at Delhi, Stonehill College, Tufts University, University of Connecticut, University of Delaware, University of Maine, University of Massachusetts, University of New Hampshire, University of Vermont, Western Kentucky University, Wilkes Community College, and Worcester Polytechnic Institute.

THE HERBARIA

Dr. Peter Stevens supervises the combined herbaria of the Gray Herbarium and the Arnold Arboretum. Herbarium policy is formu-

lated and overseen by the Herbarium Committee, of which he is the chairman. Other members are the director (ex officio), Michael Canoso, and Drs. D. H. Pfister (Farlow Herbarium), O. T. Solbrig (ex officio, Gray Herbarium), R. M. Tryon (Gray Herbarium), and C. E. Wood, Jr.; Ida Hay and Walter Kittredge are observers.

During the year Patricia Adakonis, curatorial assistant, resigned and was replaced by Howard Farkas, who works part-time. Walter Kittredge has been working two days a week helping to curate the Oakes Ames Orchid Herbarium under the National Science Foundation Curatorial Grant. This has released a further full curatorial assistantship, which was filled for a time by Julie Zickefoose, and now by Martha Tack. Philip Cantino joined us as a temporary phanerogamic botanist to work on the type project under the NSF Grant; he resigned on May 31. He was assisted by Sandra MacLaren, curatorial assistant, for part of this time.

Although the compactors were installed last year, owing to technical problems it is only recently that an order for gaskets, to make them airtight, has gone in, and there are still modifications to be made on the locking devices. However, one bank of compactors was made insect proof after installation of gaskets, a locking device that exerts enough pressure and yet allows plenty of space in the aisles when open was installed, and individual compactor units were aligned. The Fagaceae and Ulmaceae were transferred to this bank, which seems to be working satisfactorily and to have space for future accession. Further shifting of specimens in association with the move has been carried out, and plans for the move finalized. Labels for the move are being made, and if experience with the Ulmaceae and Fagaceae is any guide, this should be carried out fairly smoothly.

The total number of sheets in the Arnold Arboretum holdings at Cambridge at the end of the fiscal year was 1,112,633; 10,359 sheets were mounted, nine were added directly, and 41 removed. One hundred and eighty-six further sheets were repaired. At Jamaica Plain, the total number of sheets in the herbarium of cultivated plants stood at 168,893, with the addition of 845 specimens. Sixty sheets underwent repair. Six thousand and twenty-nine accessions were received at the two herbaria, 2,977 of which were by exchange, 1,985 as gifts, 35 by subsidy, and 1,082 in exchange for identifications. The chief sources this year were eastern Asia (1,954), United States and Canada (1,045), Australia (1,009), western Malesia (557), India (423), and Papuasia (351). Five hundred and seventy-three sheets were sent on exchange during the year, and 106 for identification; 2,015 were received on loan for study by staff, and 2,842 by students; a further 790 were received for visiting scientists; 6,145 were returned on behalf of staff, and 19,546 on behalf of students; 21,879 were forwarded in response to loan requests, and 20,230 returned.

Curatorial staff annotated 1,800 further sheets in Anacardiaceae, a project started in the previous year following the revisions of Ding Hou; 425 Malesian Labiatae after Keng; 250 Olacaceae after

Sleumer; 100 Malesian Ulmaceae after Soepadmo; 175 Malesian *Caesalpinia* (Leguminosae) after Hattinck; 40 Guyanan Bonnetiaceae after Maguire; and 700 Malesian Araliaceae after Philipson; 30 Australian Chloranthaceae were also annotated. Material was annotated in Rubiaceae and 13 new genera folders prepared following Ridsdale's recent publication; *Meliosma* (Sabiaceae) was rearranged following van Beusekom. Collections of *Garrya* made by G. V. Dahling were divided for distribution. The recently acquired Schaeffer collection of West Indian plants is being prepared for incorporation. Altogether, 34 new genera have been added to the collections. One hundred and three specimens were photographed, including 50 types which were sent on loan.

At Jamaica Plain, the relocation of nearly half the herbarium of cultivated plants was the major undertaking of the year. This was supervised by Ida Hay, the curatorial assistant responsible for this herbarium. Although much was accomplished, there are still several tasks to be completed before the herbarium will be back to normal. In order to provide space for offices on the first floor, 86 cases, containing 70,000 specimens, were moved from the first to the fourth floor of the herbarium wing of the Hunnewell Building. To prepare for this move, work began in autumn, 1980, on the reorganization of materials stored on the fourth floor. The carpological collection occupied ten wooden cases and six tiers of library shelving. With the help of Volunteer Emily Roberson, a Harvard undergraduate, this collection was consolidated to occupy only five cases with room for future expansion. By mid-December, the fourth floor was cleared. In one week the grounds staff, with Superintendent Henry Goodell, Assistant Superintendent Patrick Willoughby, and Ida Hay, moved all 86 cases. Specimens were removed from the cases and lifted, half a case at a time, by means of the aerial bucket of the High Ranger truck. The cases were disassembled and moved by the same route. In this way, the order of specimens in the herbarium was maintained. The work of leveling, straightening, locking the cases back together, and replacing the doors was completed in early January.

On the second floor, mounting supplies that were stored in the central area, formerly the clerestory, were inventoried and moved elsewhere on that floor and to the attic. A new, reinforced floor was built by a contractor and the railing around the area removed so that this space could be fully used. A large work counter was moved from the first floor and reassembled there. The Gray card index was also moved to the center of the second floor, and the Rehder index was relocated in the library corridor on the third floor. In order to accommodate the relocation of work space and offices of staff who use the herbarium on the second floor, and to use eight of the cases on the fourth floor to house the unmounted, boxed *Yucca* and *Agave* collections of S. D. McKelvey, the herbarium there had to be further shifted once the main move was complete. Canoso, Hay, and Roberson worked on this. The work space for herbarium preparators was moved

from an alcove in the herbarium to the office adjacent to the herbarium on the second floor. The cooperation, care, and effort of the superintendent, his assistant, and the grounds staff were invaluable throughout the herbarium move.

The processing of 600 Merrill cartons of unmounted material has begun. Some material collected by Fernandes has been identified, the Arboretum's set mounted, and duplicates separated for exchange. Other material by the same collector is also awaiting dispatch in the course of exchange. Checking of the large collection made by W. P. Fang has begun; identifications are being checked, labels typed, and specimens mounted.

Our well-known *Crataegus* collection, which is housed in the Jamaica Plain herbarium, is being reorganized. Types have been removed to the end of the genus, and the whole genus is being alphabetized as a returned loan of almost 1,400 specimens is inserted.

The collections program in the living collections was reinitiated this spring, with goals to obtain one flowering and one fruiting specimen of every accession for our use in verification and documentation, and to obtain duplicate material, when appropriate, to use for exchange. At the end of May, 1981, Volunteer Annette Logan, a forest biology student at Colorado State University, arrived to spend the summer on this project. Using a copy of the computer printout and a set of the most recently revised maps of the collections to monitor the work, she made 235 collections by June 25, 1981. Volunteers Thaisa Way and Emily Roberson have assisted on this project. The collection of herbarium specimens from plants in the living collection with documented Asiatic origin also continued in 1980–1981. Volunteers Susan Davis, Cora Warren, and Mary Wolcott made ten sets of 125 collections this year. The collection of our *Crataegus* accessions was continued by Hay, Warren, and Davis, who made 25 collections in fruit. In anticipation of removal and repropagation of much of the *Corylus* collection, specimens were made of all accessions in that genus.

The herbarium welcomed 179 visitors this year, of which 137 were from the United States, and a further 17 from elsewhere in the New World, the balance being from the Old World.

THE LIBRARIES AND ARCHIVES

After almost seven years as librarian of the Arnold Arboretum, Mrs. Lenore Dickinson retired on March 5, 1981. The current librarian, Ms. Barbara Callahan, joined us on March 1.

The librarian is chairman of the Library Committee. The other members, besides the director (ex officio), are Dr. Alan Erickson (Harvard libraries; ex officio), Ms. Sheila Geary, Dr. Richard Howard, Dr. Elizabeth Shaw (Gray Herbarium), Dr. Otto Solbrig (Gray Herbarium, ex officio), and Dr. Stephen Spongberg. The library support staff consists of Ms. Sheila Geary, horticultural research archivist, responsible

for the library in Jamaica Plain, and Ms. Anne Thacher and Ms. Mary Thomas, library assistants. A third library assistant, Ms. Carol Rothstein, resigned March 20, 1981; her position will not be refilled.

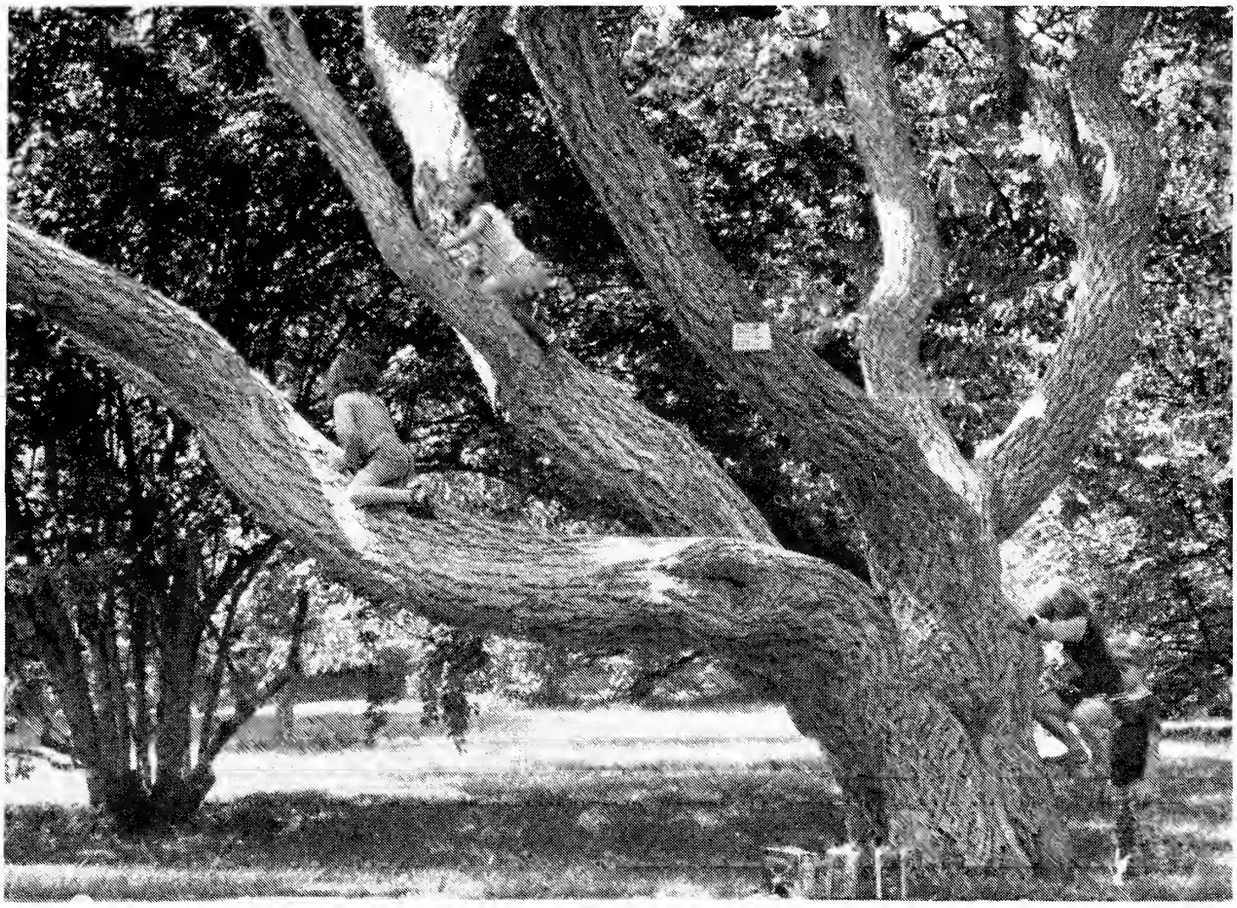
During the year our total holdings of volumes and pamphlets reached 87,967; 185 titles had been added by cataloguing, and 122 titles by binding; 30 volumes were deaccessioned, including 10 duplicate volumes through sale; 187 reprints were catalogued, and 42 microfilms added. We wish to acknowledge the following donors of volumes to our library: Mrs. Forrest Davison, Mr. G. K. Fenderson, Dr. Shiu-ying Hu, Dr. Richard Howard, Mr. Ray Millman, Mrs. William Moore, Dr. Franklyn Ott, Dr. Richard Schultes, Dr. Elizabeth Shaw, Dr. Peter Stevens, Dr. Herman Sweet, and Dr. Barry Tomlinson.

Most of the Cambridge library had been shifted to the new space provided through the building extension in the previous year. The folio and monograph collections are still in the process of being reshelved.

During the winter months the first phase of the projected library reorganization in Jamaica Plain was implemented. With assistance from Mr. Henry Goodell, Mr. Patrick Willoughby, and members of the grounds staff, Ms. Sheila Geary removed all library material, with exception of the staff reference section, from the first floor. The move included a complete rearrangement of the entire monograph section of the library. This rearrangement now places all library holdings on one floor in the Hunnewell Building, shelved in the correct classification sequence, and with ample room for expansion. In addition the photograph collection was moved from the second to the third floor, and the archive collection was assembled in one location to facilitate its eventual move to new office space on the third floor. The reorganization and relocation of the library, photograph, and archive collections will ensure more control and improved management and conservation, yet will allow better access to the collections. As a finding aid to the new arrangement, a revised guide to the library has been prepared.

The second phase of the library move, now in the planning stages, involves the journal collection. Although housed with the rest of the collection on the third floor, over half of the journals occupy space that serves the dual purpose of both library stacks and staff offices. These journals will be moved to new stacking, already on hand, to be assembled across from the newly relocated monograph collection.

The arrival of the new librarian coincided with the phasing out of the Monograph Cataloguing Support System. As a new processing center, to be called the Harvard College Libraries Faculty of Arts and Sciences Cataloguing and Support Services, is due to begin on July 1, 1981, Ms. Callahan and Ms. Geary provided temporary cataloguing in the interim period. The new system will provide central cataloguing and terminal services for all new titles, including original cataloguing. Call numbers will continue to be provided, for the present, based on our libraries' unique classification system.



Phellodendron amurense *in summer and winter at the Arnold Arboretum. Each season has its burden to carry. Photographs by A. Bussewitz.*

In Jamaica Plain, Ms. Sheila Geary has been fortunate in receiving help from volunteers. Each year their contribution is measured in hours spent filing, shelving, and sorting. The immeasurable contribution comes in the dedication, care, and interest they bring to the library. During the past year Muriel Bergdorf worked on the journal records, filed catalog cards, and accomplished a great deal on the long-term project that will integrate the index of our archival letter file with the indexes in the bound archival letterbooks. Jane Morss prepared material for binding, tracking down missing pieces. She organized the oversize book collection, annotated the cards, and labeled each book. Mrs. Cora Warren spent each morning on the photograph collection. Her extensive work included the organization of the lantern slide collection. Gathered from all recesses of the building, this collection of over 4,000 slides is now sorted and labeled by subject. In the photographic print collection two filing systems have been merged. Mrs. Warren's work now enables the user to locate all historical prints of a specific genus in the collection regardless of geographical location. This new system is being expanded also to include the current photograph collection.

An inventory of the combined archives of the Arnold Arboretum and the Gray Herbarium has been started through the NSF grant. Ms. Lynn McWhood has been appointed to undertake this task directed by Dr. Shaw.

PUBLICATIONS

Our policy for publications is defined and monitored through a joint committee, with the Gray Herbarium, under the chairmanship of Dr. Bernice G. Schubert. The members are Ms. Elizabeth Schmidt, Dr. Peter Ashton (ex officio), Dr. Otto Solbrig (ex officio), Mr. Carl Lobig, Dr. Stephen Spongberg, Dr. Peter Stevens, Dr. Donald Pfister, Dr. Richard Weaver, and Dr. Carroll Wood.

Mr. Carl Lobig assumed the position of publications officer for the Arnold Arboretum on September 1, 1980, taking over from Mr. Norton Batkin, who had resigned to pursue his Ph.D. in philosophy at Harvard University. At the time he assumed responsibilities, *Arnoldia,* the bi-monthly horticultural publication of the Arnold Arboretum, was six months behind schedule. Most of his first nine months were therefore directed to rectifying *Arnoldia*'s schedule difficulties, while at the same time undertaking design and layout changes that will help to make *Arnoldia* a more marketable publication. Since September, 1980, six issues of *Arnoldia* have been published, including the first two numbers of Volume 41. *Arnoldia* will be up to date as of the January, 1982, issue, Volume 42, Number 1. Accelerating *Arnoldia*'s production schedule necessitated a change of printers, a move long under consideration for financial reasons. Heffernan Press of Worcester, Massachusetts, has been chosen. Although still on a trial basis, Heffernan's work seems to be more than satisfactory and offers significant improvements.

As the primary benefit of membership to the Arnold Arboretum, and as the Arboretum's major publications link to the general public, it is important to maintain and develop *Arnoldia*'s standards while at the same time increasing its popular appeal so that it may become self-supporting. In the initial stage this means improving its graphic appeal. A number of major steps have already been taken over the past year. They include special attention to photographic presentations; a new, more striking logo design combined with a move to a four-color cover which began with Volume 41, Number 1; a better-quality cover paper; and a more varied photographic treatment. These initial changes, combined with the return to a regular publishing schedule, have brought *Arnoldia* considerably greater attention and pave the way for future promotional efforts. This year we also began a program of distribution to horticultural bookstores on a trial basis. Further changes are under consideration.

In attempting to bring a wider readership to *Arnoldia,* we have begun soliciting articles from within and outside the Arboretum on a diversity of subjects. This year saw the publication of Dr. Richard Howard's two-part historical profile of E. H. Wilson as a botanist (Vol. 40, Nos. 3 and 4) and a special issue devoted to *Magnolia,* timed to appear at the American Magnolia Society's annual convention held at the Arnold Arboretum in April. *Arnoldia* continues to provide a place for publishing horticultural research associated with the Arboretum: Mr. Peter Del Tredici's prolific contributions included research on *Tsuga canadensis* f. *pendula* and *Magnolia virginiana,* while graduate student Mr. Michael Donoghue contributed a study of growth patterns with examples from his research on the genus *Viburnum.* Meanwhile, plans are being developed for further thematic issues aimed at particular horticultural interest groups as potential subscribers. A major promotional mailing is planned for 1982.

With *Arnoldia* coming back on schedule, Dr. Richard Weaver became associate editor and took over as technical advisor from Dr. Bernice Schubert beginning January, 1981. Mrs. Barbara Epstein continues to act as circulation manager.

The editor of the *Journal of the Arnold Arboretum* is Dr. Stephen Spongberg; Ms. Elizabeth Schmidt is managing editor. The Editorial Committee remains the same as last year. Four numbers of the *Journal* appeared during the year. Despite this, the *Journal* was one issue behind schedule at the end of the year. It is intended that all numbers of Volume 62 will appear during calendar year 1981.

Volume 61, Nos. 2 and 3, were devoted entirely to Dr. Stevens's "Revision of the Old World Species of *Calophyllum*" and were issued simultaneously on December 19, 1980. These two issues, the largest in the history of the *Journal,* numbered 582 pages and included a special index. A total of 792 pages were devoted to the eight articles by ten authors published in the past fiscal year. Dr. Richard Howard, former staff member Ms. Kristin Clausen, and Dr. Peter Stevens were Arboretum staff who published in the *Journal* during this period,

while Dr. Walter Judd published the first installment of his monograph of *Lyonia* (Ericaceae), which was based on the thesis he prepared while a graduate student under Professor Carroll Wood's guidance. Three of the ten authors were associated with foreign institutions. Manuscripts are presently on hand for issues into Volume 63. Twenty-four manuscripts were received during the past fiscal year; of these three were rejected, two are currently being reviewed, and the remainder have been accepted for publication.

A new cover design, which is embossed on off-white cover stock, utilizes the logo drawn by Mrs. Karen Stoutsenberger Ku, and the same design reduced in size is being used as the device on the reprint covers. It is intended that this logo be associated with the *Journal* for many years to come. As a result, new cover designs will not have to be prepared on an annual basis.

Special recognition should be given to Ms. Schmidt for her unflagging efforts to cope with the work load in the editorial office during Dr. Spongberg's absence in China and, after his return, in her efforts to put the *Journal* back on schedule. Mrs. Mary Ashton, Mr. Mellard Ashton, Ms. Margaret Campbell, Dr. William Curtis, and Dr. George Proctor are also thanked for assisting in the thankless job of reading galley proofs.

Other areas of activity in the publications department were recently limited by the overriding needs of *Arnoldia*. Some progress is now being made. In conjunction with Ms. Eugenia Frey, Mrs. Barbara Epstein, Ms. Hope Wise, and the director, plans were made to integrate the publishing of the Arboretum into our overall development plan for public services, covering the next four years. This includes development and marketing of *Arnoldia*, production of new brochures and promotional pieces, and development of educational programs and displays. In order to supervise scientific accuracy, Dr. Bernice Schubert, representing the Publications Committee, has volunteered to review materials before publication. Our latest publishing venture, our *plantSciences* newsletter, is reported on in the section on public programs.

An inventory of publications in Jamaica Plain has been undertaken with the help of volunteers, subsequent to moving back stock from newly allocated library shelves to a publications storage area. A procedure for billing and tracking stock flow has been put into effect which will, in addition to keeping more accurate records, generate a mailing list of interested horticulturalists. Over 500 names and addresses have already been compiled. Negotiations are under way for a new mailing house, and plans are being made to computerize all our mailing lists for the first time.

The photographic collections continued to receive careful attention from Volunteer Mrs. Cora Warren, while Volunteer Mrs. Dodie Loomis diligently supervised the curation of the slide collection. As our resources have become better known, requests for their use have increased, making comprehensive cataloguing and curation increas-

ingly urgent. This year we provided photographs on a fee-for-use basis to major publishing houses including Beacon Press and Houghton Mifflin, and to the magazines *Horticulture* and *New England Outdoors*. A proposal to provide over 1,000 photographs for a book on landscape architecture is currently under consideration.

LIVING COLLECTIONS

The Living Collections Committee consists of Plant Propagator John Alexander, Assistant Supervisor of the Living Collections James Burrows, Superintendent of Buildings and Grounds Henry Goodell, Records Coordinator Jennifer Hicks, Drs. Stephen Spongberg, Peter Stevens, and Richard Weaver, the director (*ex officio*), with Mr. Jonathan Shaw, director of the New England Wildflower Society, as outside member; the supervisor of the living collections, Mr. Gary Koller, is chairman.

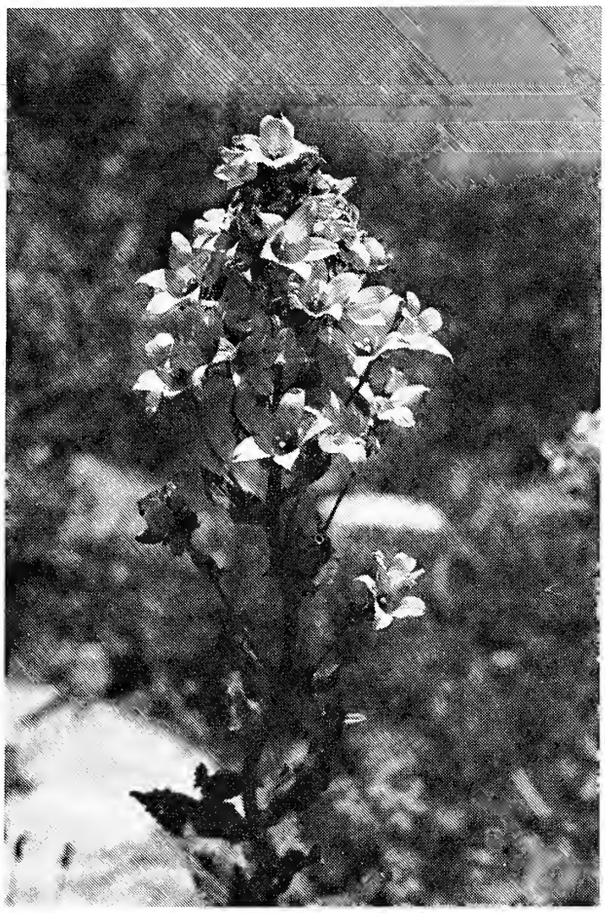
Substantial progress has been made in the curation of the collections in Jamaica Plain again this year, including major acquisition of new material, in the preparation of the accessions records prior to their entry into computer storage, and in general restoration and maintenance of the grounds. Plans are being made for more intensive utilization of the Case Estates.

Detailed planning of accessions had been the responsibility of Dr. Weaver and Supervisor Koller. Due to the very dry summer and fall of 1980, the fall planting was kept at a minimum. Essentially the only planting done was a large number of rhododendrons sited near the South Street Gate. Eighty-two accessions of 77 taxa and cultivars, a total of 150 plants, were set out. The species material, a total of only nine plants, was planted at various locations on the grounds. By far the largest percentage of plants, consisting entirely of *Rhododendron* cultivar material, was planted at the base of Hemlock Hill near the South Street Gate. This area has been the Arboretum's traditional collection of evergreen *Rhododendron* and consists almost entirely of cultivars owing to the paucity of species that are hardy in our climate. By far the largest and most conspicuous component of the collection has been the series of *R. catawbiense* hybrids and cultivars known as "ironclads." The collection, particularly that part nearest the road, has declined over the years and has not presented a particularly good appearance to the numerous visitors entering through the South Street Gate as well as general visitors coming to see the rhododendrons when they are in bloom. During this planting, gaps in the borders were filled with both deciduous and evergreen *Rhododendron*, with an attempt to select cultivars that would increase diversity and harmony in color, height, and flowering time; unsightly plants were relocated or moved; and a new series of beds was established across Bussey Brook along the southeast edge of Hemlock Hill. All planting areas were well prepared under the supervision of Mr. Patrick Willoughby and Mr. James Burrows.

The spring planting lasted from the beginning of April until the middle of June. Four hundred and ninety-four plants were set out, representing 172 accessions of 158 taxa and cultivars. Included were 85 plants of 30 different cultivars. In addition, 15 accessions of 14 taxa were moved from the shrub collection; most of these plants were divided before they were replanted in their new locations. Ten of these are cultivars of *Paeonia suffruticosa,* and 11 are cultivars of *Rhododendron nakaharai* developed by Mrs. Julian Hill of Martha's Vineyard, a recently retired member of our Visiting Committee. One hundred and thirty-one plants of 31 accessions of 27 taxa represented the first major planting resulting from the Spongberg-Weaver expedition of 1977 to Japan and Korea. The plantings were done according to the Bentham and Hooker sequence, and a number of new plantings begun last year were strengthened. The only new family replaced in taxonomic sequence is the Calycanthaceae. Several taxa of *Calycanthus* were planted in the Azalea Border and in the Liriodendron collection. Fifty-four plants of *Cytisus* as well as 13 plants of other shrubby legumes were planted among the *Colutea* and *Caragana* along the Arborway wall behind the Vine Trellis. This area will be the primary collection of shrubby legumes. For cultural and esthetic reasons these plants are unsuitable among the arborescent legumes. The *Hydrangea* collection was relocated from the shrub collection to the edge of the *Acer* collection along the Meadow Road. The Chinese Path area on Bussey Hill received a number of accessions. Several species of Chinese trees were added to the azalea and *Enkianthus* beds for shade. Several Chinese plants, which were first exhibited in the Flower Show, including *Rhododendron schlippenbachii, Dicentra spectabilis,* and *Liriope spicata,* were planted among the *Stewartia* collection. Also, several bamboo species and tree peonies were planted in the old *Cytisus* bed. The grass strip between the sidewalk and the roadway, in the vicinity of the Forest Hill gate, was formerly occupied by hedges of roses. We hope to replace these eventually, and an experimental planting of two polyantha rose cultivars was begun near the Forest Hills gate.

The phased replacement of the shrub and vine collection was begun. Approximately 225 existing plants on the three-acre site were evaluated. Plants will be relocated, repropagated, and in a few cases disposed of. The first sections of the existing shrub garden were closed down by grassing in. With assistance from the New England Rose Society the rose collection was reviewed and names verified. Dr. Weaver then went through the collection to remove unnamed or overgrown accessions and separated those to be retained. Vines of various genera were planted on the Arborway and Adams-Nervine fences.

Most of the *Alnus* planted along Willow Path last fall did not survive, primarily because they could not be dug properly because they were too close together in the nursery. The dead plants were replaced this spring. The torch azaleas (*Rhododendron obtusum* var. *kaempferi*) were killed back badly last winter. The planting beneath



Dr. Richard Weaver of the Arboretum's staff journeyed to the U.S.S.R. in August, 1980, to participate in a plant hunting expedition. Above left: Campanula lactiflora, *a late-blooming, 3–4 foot tall bellflower in the Northern Caucasus Mountains of the U.S.S.R.* Above right: *A somewhat overenthusiastic Soviet conservation poster. Loosely translated, the sign reads "More than 30,000 species of plants have become extinct at the hands of man."* Below: *The main range of the Northern Caucasus with the two most important coniferous trees of the upper slopes in the foreground: Nordmann fir* (Abies nordmanniana) *on the left and oriental spruce* (Picea orientalis) *on the right. Photographs by R. Weaver.*

the oaks, just before the ponds, was largely reworked this spring. Unsightly plants were pruned back and consolidated into tighter groups, and the poorest plants were removed entirely. Fifty plants were purchased and were used to reconstitute the original groups. The groupings were mulched with shredded leaves rather than the customary wood chips, to reinforce the naturalness of the plantings. Major pruning of the willow collection and associated plantings was undertaken, mainly by Pruner Mark Walkama. Eight large specimens, which had been repropagated, were removed. Review of the *Malus* collection continued to determine which trees flower and fruit poorly as well as being susceptible to foliage and fruit diseases. After being evaluated, and in some instances repropagated, approximately 40 mature specimens were removed. During the summer, 1980, there was a major removal of thin, weak, or declining plants in the *Syringa* collection. The *Ulmus* collection continues to be affected by Dutch elm disease. It was necessary to remove 16 more mature trees which had died or were affected by the disease. While it is not often noticed, a great many poor and declining specimens have been removed from various collections. These plants had previously been repropagated or replaced.

From August 3 to September 20, 1980, Dr. Weaver participated in the fifth of a series of joint plant-collecting expeditions coordinated by the Cary Arboretum of the New York Botanical Garden and the Academy of Sciences of the U.S.S.R. The other American participants were Mr. Robert Hebb and Dr. Frederick Seaman, both of the New York Botanical Garden. The objective was to collect seeds or living plants, documented with herbarium specimens, from the wild for cultivation in the United States. They concentrated on the steppe flora of European Russia and the forest and alpine flora of the Northern Caucasus Mountains. Just over 300 collections were made. Germination of the seeds has been quite good. Due to the poor woody flora in the areas visited, only about 70 of the collections were of woody plants, but many of the herbaceous collections will be used in educational exhibits or offered to other institutions for exchange.

Dr. Stephen Spongberg's participation in a joint Sino-American expedition to Hubei Province, China, has been reported in the section on research. In addition to the herbarium collections, nearly 600 seed collections were obtained on the China expedition, all vouchered by herbarium specimens as well. In addition, 42 miscellaneous collections of seed were made during the course of travels in China once the expedition itself had been concluded. A share of all but a small percentage of these living collections has been received at the Arnold Arboretum and is currently being processed at the Dana Greenhouses. It seems likely that several new introductions to cultivation in the West are among these acquisitions.

Altogether, 171 shipments consisting of 1,536 taxa were raised this year for propagation in response to requests from 21 countries. In addition, 336 taxa were propagated to prepare replacements for exist-

ing specimens in decline. Notable donations of plant materials, which have been used as understock, were received from Hess Nurseries, Cedarville, New Jersey; Princeton Nurseries, Princeton, New Jersey; Lawyer Nurseries, Plains, Montana; Weston Nurseries, Hopkinton, Massachusetts; and White Flower Farm, Litchfield, Connecticut.

Much progress has been made in the verification of the plant records and the mapping and labeling of the collections in the past year. Information and assistance provided by Mr. Burrows has made possible an intensive records update and relabeling of the plantings at the Case Estates. In Jamaica Plain volunteers and horticultural trainees have assisted in extensive field checking, the replacement of labels on more than 1,000 plants, and the preparation of labels for placement on an additional 700 plants during the summer of 1981. Mr. Charles Mackey of the grounds staff devoted the winter to the preparation of display labels for placement during the spring and summer. Horticultural Trainee Timothy Byrne, a student at the University of Massachusetts in Amherst, completed replacement labeling and remapping of the plantings surrounding the Hunnewell Building and a section of the Azalea Border on Meadow Road during the spring of 1981.

Field checking has this year identified nearly 500 existing plants which had not previously been included in the plant records. New plantings and the relocation of existing plants have been recorded and mapped as completed. Because special effort has been taken to deal with areas in which mapping and labeling are known to be problematical, portions of many grounds maps have been field checked and updated. Six maps have been fully updated and will be redrawn; three maps have been updated but will not be redrawn due to scheduled redesign or collection development; six maps have been redrawn.

Implementation of the plant records documentation and computerization project, funded by the National Science Foundation, began with the appointment of Ms. Patricia Dalton as research assistant for records documentation. Although she joined us in late April, she has already made significant progress in the verification of the records and their transcription into the format designed for computerization. Special mention should be made of the exhaustive library research in conifer nomenclature by Volunteer Richard Warren. His work is being coordinated with Ms. Dalton's and will prove valuable to her since nearly 1,000 of the taxa represented in our collections are conifers. It is Dr. Warren's ultimate aim to verify the entire conifer collection. In June he was joined by Volunteer Ann Carlsmith, who is making a comprehensive herbarium collection of the conifer holdings.

An ONYX C8002 computer and a Visual Technology V-400 terminal have been purchased and will become operational during July, 1981. Although entry to the plant records will not begin immediately, the use of the computer for 1981 nursery inventories, in the format designed for the living collection records, will provide an opportunity

to test its programming in operation prior to beginning entry of full records for an estimated 20,000 accessions now in permanent display positions at Jamaica Plain and the Case Estates.

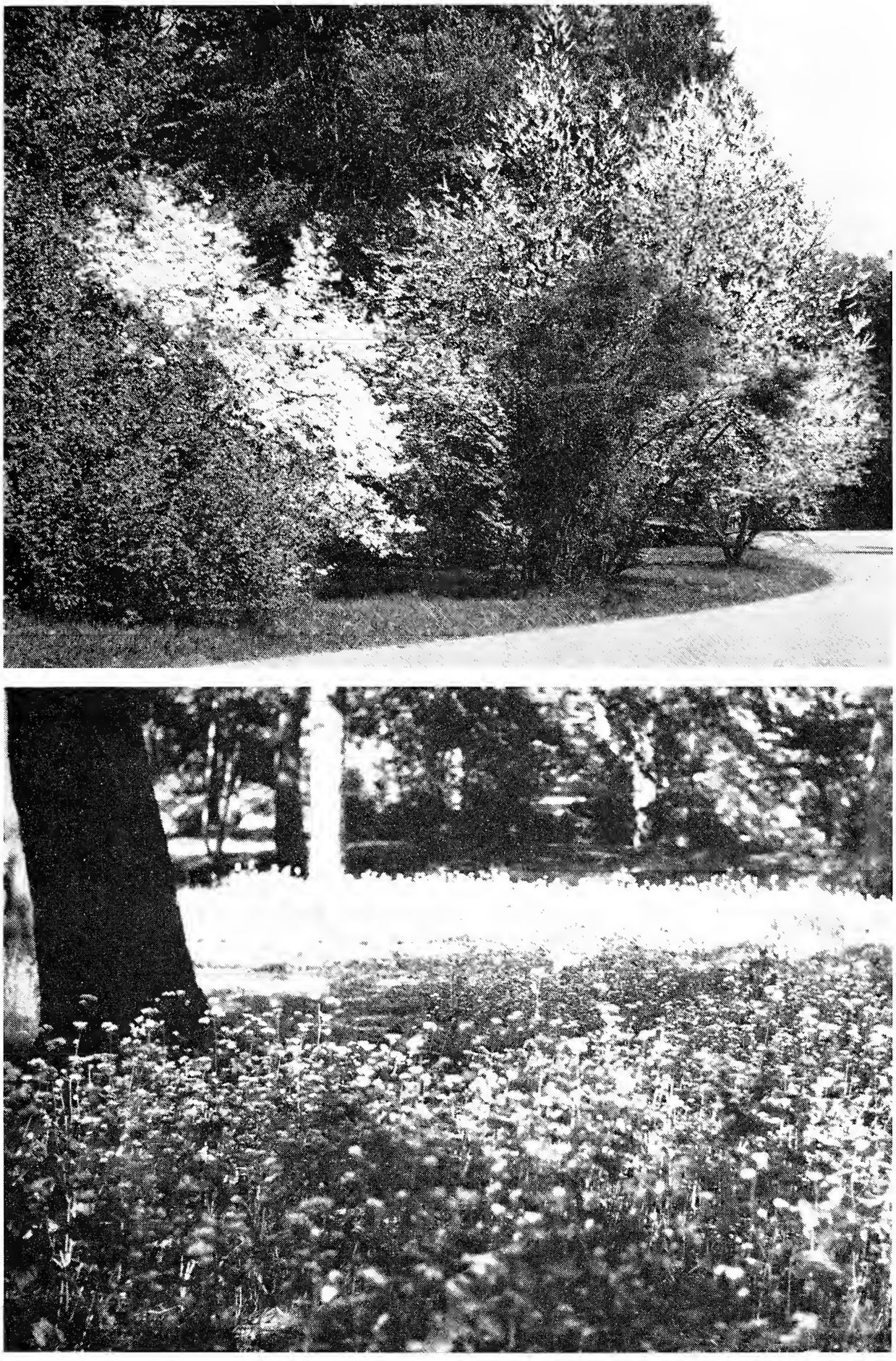
Satisfactory advances have been made in general maintenance and in the restoration of the path system. Improved planting techniques resulted in much higher survival rates in the reestablishment and vigorous growth of new plantings. Nevertheless, late-summer drought in 1980 severely weakened many plantings which were old and declining or, in some cases, new plantings which were not yet reestablished. An extremely cold winter followed, with prolonged sub-freezing conditions. In addition, the winter was somewhat dry and, with long periods of exceptionally cold temperatures, proved to be one of the worst in recent memory. These conditions combined to cause much dieback in many taxa, including *Lindera praecox, Corylopsis* spp., *Idesia polycarpa, Deutzia* spp., *Weigela* spp., *Elaeagnus umbellatus, Sasa japonica,* and *Cytisus* spp. Much additional fine pruning was therefore needed this spring, which was effectively undertaken by Head Pruner James Nickerson with Mr. Mark Walkama.

A grass fire in Kent Field in late summer led to damage and loss of a number of plants at the edge of the conifer collection. The bittersweet, which had smothered the rock outcropping next to the conifer path for many years, was cleared and, we hope, eradicated. This has exposed the lovely rock ridge. While no plans exist at present for replanting, this represents a preparatory step for future development.

Work on the Oak Path is proceeding according to schedule. The mown path is well-established, although it is still not satisfactorily delimited where it begins on Meadow Road. Several wild-flower masses were established in the summer of 1980. Two areas were planted with 1,000 each of *Cimicifuga racemosa* and *Trillium grandiflorum. Tiarella cordifolia* and the fern *Thelypteris phegopteris* were planted on the rather steep bank on the top side of the graded upper path. With the possible exception of *Trillium,* these appear to be well established and should rapidly form a ground cover. Major regrading was undertaken along Willow Path to improve its definition and upgrade the roadbed to accommodate service and maintenance vehicles.

At the greenhouses the insulation reported last year proved highly effective, and the two remaining houses were covered. Mr. Alexander and his staff have processed 102 taxa to acquire propagation data. The inventory of lilacs (*Syringa*) for susceptibility to mildew and leaf-roll necrosis continues, as do hybridization experiments among resistant taxa. This program is an important adjunct to the planned restoration of our celebrated lilac collection.

Mr. Robert Nicholson extended his studies of maples. He examined rooting responses of Manchurian maples and attempted induction of somatic mutation in *Acer palmatum* by colchicine injection. Mr. Nicholson also carried out experiments in hormonal injection of cuttings of recalcitrant conifer species in an attempt to induce rooting.



Above: *The entrance to the new Arcto-tertiary Path off of Valley Road near the beech collection. Flowering trees are dogwoods* (Cornus florida) *on the left, and silverbell* (Halesia carolina) *on the right.* Below: *A meadow planting was begun along Oak Path in the spring of 1981. Here, the cover crop of buckwheat is in full bloom. Photographs by R. Weaver and S. Geary.*

At the Case Estates drought affected the fall, 1980, operations too, but 500 *Syringa* species and cultivars were transplanted to the 950 section of the nursery. These plants are to be used in the restoration of the lilac collection. Rows 1–40 and 120–160 were prepared and planted with 1,400 plants from the Saran houses. These represent replacement propagation and plants from the Spongberg-Weaver expedition to Japan and Korea. The established nurseries are now almost full. Consequently, a water main has been installed on the opposite side of Wellesley Street, entering the old pruning demonstration plot which is to be removed. This will provide an irrigation source for the whole of this section of the Estates. Initial steps have been taken to open a new nursery, sufficient for 2,640 plants, which will open in spring, 1982. A quarter of the area has been plowed and prepared, and a cash crop planted to offset the cost of the operation.

The inventory of the permanent nursery was completed in 1980 and checked against records. Much has been lost, but much also remains. Detailed accession information, including living collections map locations of the same accession or the same taxon with its accession data where such exist, has been collected in order to determine which plants should be repropagated for return to the living collections. The process of repropagation will be delayed except in the case of declining specimens, owing to the current pressure on nursery space.

The Massachusetts Chapter of the American Rhododendron Society commissioned a landscape architect, Mr. John Gwynne, to draw up a schematic plan of the proposed garden which they intend to install, with the collaboration of the Arnold Arboretum, in the woods at the Case Estates. In order to implement the design, Arboretum staff have continued tree thinning and cleaning; Mr. Burrows laid out the route of the primary path system. The first batch of rhododendrons presented by the society has arrived at the Case Estates for planting in final positions next spring.

The street-tree plot was surveyed in 1980. The trees were overcrowded, many were damaged or diseased, and few were labeled. Poor trees were removed and repropagated, some new trees were planted in the spring, and all were labeled. Further renovation also occurred in the ground-cover plots, and some new covers were added. This display is now in excellent condition and, once the new ground covers have grown, should need minimum maintenance.

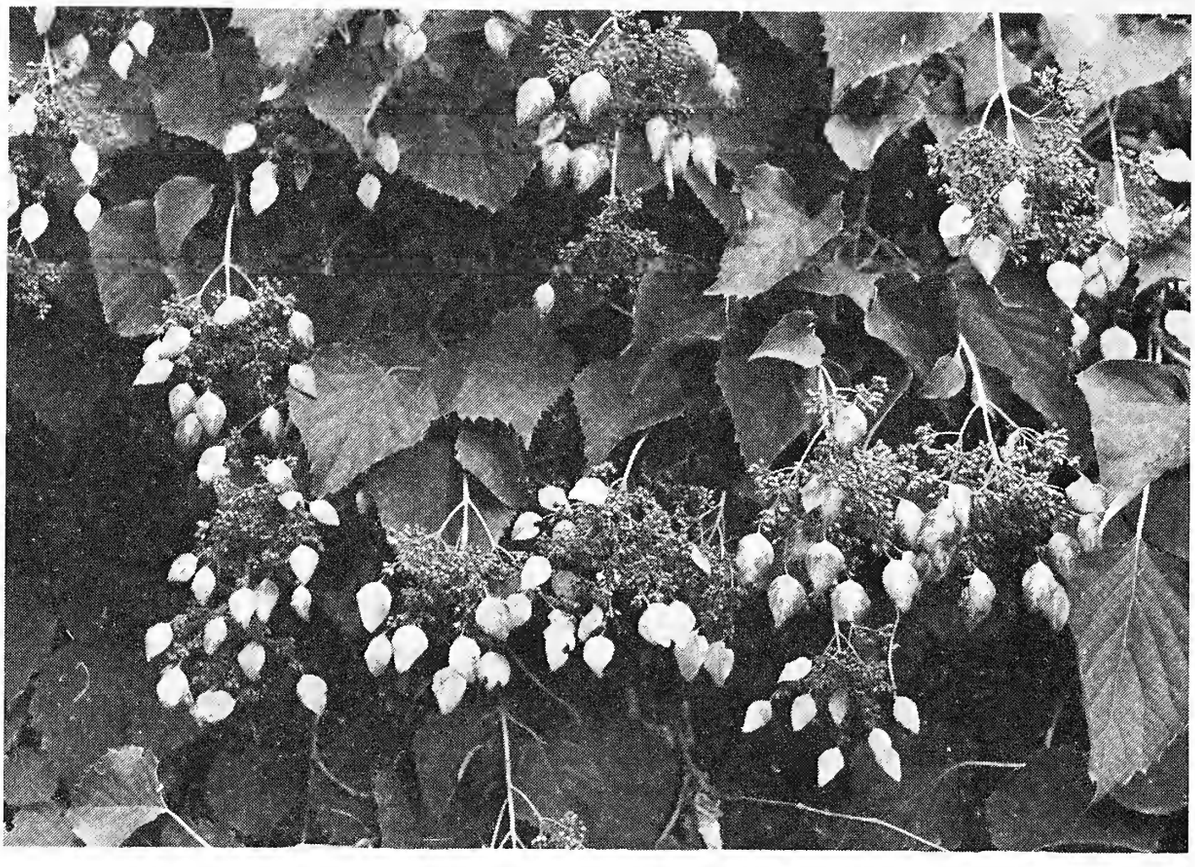
Assistant Supervisor James Burrows and Horticultural Taxonomist Richard Weaver, with help from a group of volunteers, have made major changes in the old Low Maintenance Perennial Garden, which is to become the American Garden, an interpretive display of selected American native herbaceous species and the cultivars that have been derived from them. Beds were redesigned, and perennials propagated in the fall. Some of these were planted out in the spring, but the garden will not be completed for another year.

A one-year, renewable agreement has been signed between the Arnold Arboretum and Land's Sake, Inc., of Weston, to use land in the

Ground covers have long been a popular educational exhibit at the Case Estates. These plantings were improved by the removal of declining plantings, the addition of new plants for trial, and general reorganization of those plants growing next to the stone wall along Alphabet Lane.

forty-acre field at the Case Estates to grow vegetables and small fruit for sale to local markets. The work is subcontracted to Land's Sake, Inc.; any losses or gains made will be the Arnold Arboretum's responsibility. This year, work was started on a trial basis. A quarter-acre each of raspberries and strawberries were planted, and one acre of squash. A further five acres were plowed and planted to a cover crop. Land's Sake, Inc., is a nonprofit corporation open to any Weston resident. It is dedicated to the education of farm and forest management practices and to aiding the small home gardener. For the Arboretum this represents an attempt to offset the increasing costs of running the Case Estates by generating revenue from unused land. This new venture initially attracted some adverse comment from our neighbors, but a public meeting was held, and our endeavor has subsequently received interest and support.

Our staff, as usual, provided a variety of horticultural service to our colleagues and the public. During the year, 189 shipments of plant material, comprising 1,094 taxa, were distributed to cooperating institutions, nurseries, and individuals in 12 countries. We are particularly happy to have been able to assist Professor Bruce Tiffney of Yale University by providing unusual and interesting plant materials which will be used to reestablish the Marsh Botanical Garden. Mr. Nicholson mounted expeditions to localities throughout New England on his own initiative, to collect *Acer saccharum* from selected provenances for the Chinese Academy of Forestry, Peking. Three species of



Schizophragma hydrangeoides *is a little known ornamental vine which climbs by aerial rootlets. Seeds and culture instructions were distributed to nurserymen at the 1980 meeting of the International Plant Propagators Society. Photograph by C. Lobig.*

Magnolia were given to members of the American Magnolia Society during their annual convention which was held at the Arnold Arboretum in April, 1981, and was organized by Drs. Howard and Spongberg and Mr. Koller. Seeds of *Sorbus alnifolia* and *Schizophragma hydrangeoides* were also distributed to members of the International Plant Propagators Society at their Eastern Region Convention held in Boston in December, 1980. Mr. Alexander and Mr. Koller moderated the New Plants session at the convention. Dr. Spongberg continued to serve as registrar for cultivar name registration, but from January 1, our responsibilities became limited to the 11 genera for which the Arboretum acts as International Registration Authority. Miscellaneous registrations are now being handled by the U.S. National Arboretum.

Living collections staff members acted as consultants to several public and private properties, responded to numerous inquiries by letter and telephone, contributed to lectures and tours, and guided visiting colleagues about the living collections, including the Magnolia Society, the International Plant Propagators Society, and the National Association of Olmsted Parks. Dr. Ashton serves on the Board of Trustees of the Massachusetts Horticultural Society and the Corporation of the Museum of Science; Mr. Koller serves on the Board of Trustees of the New England Wildflower Society, where he is chairman of the Garden in the Woods Committee, and on the Board of Directors of the Jamaica Hills Association, Jamaica Plain. Drs. Ashton, Howard, and Spongberg judged at the New England Flower

Show. Mr. Koller organized the judging panel for the 1981 Arnold Arboretum Award, presented at the show, which was won by Mr. Alan C. Haskell of New Bedford, for exceptional landscape use of the American native *Pachistima canbyi*. Mr. Koller also judged at the New England Camellia Show, the New England Flower and Garden Show, and the Philadelphia Spring Flower Show. Staff gave numerous talks to garden clubs and other private organizations during the year.

No new living collections staff appointments were made during the year. Grounds staff member Mr. Ralph Benotti has been out of work, due to illness, since January. Several staff have attended courses: Mr. Henry Goodell and Mr. Maurice Sheehan participated in a course on insects and disease, and Mr. James Papargiris in a course on landscape design at Massachusetts Bay Community College; grounds staff member Mr. Bruce Munch was sent to Wakehurst Place, a substation of the Royal Botanical Gardens, Kew, for four months to obtain experience in practical horticulture. Assistant Superintendent Patrick Willoughby has been awarded a one-year scholarship by the National Federation of Garden Clubs, Northeastern Region, to study horticulture at the University of Reading, England, in association with the Royal Botanical Gardens, Kew.

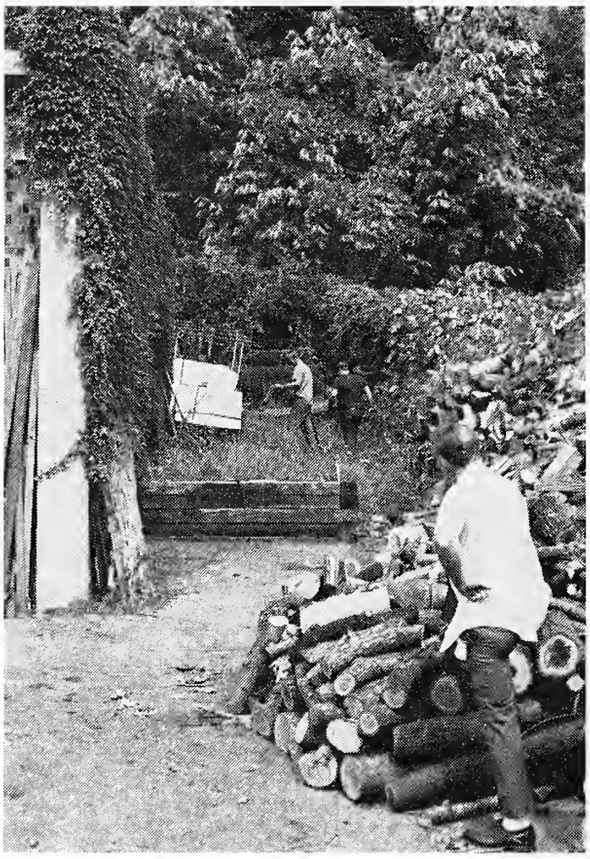
Mr. Tom Park, a longtime resident and superintendent of the Hillcrest Gardens and Case Estates, died in February. Tom will be remembered with affection by all our staff. Dr. Howard contributed an obituary in our summer, 1981, *plantSciences* newsletter.

PUBLIC PROGRAMS

Our public programs policy is formulated through the Public Relations and Education Committee. The manager for public services, Ms. Wendy Marks, is currently interim chairman. Members are Mrs. Barbara Epstein, Friends coordinator; Ms. Eugenia Frey, plant information and education coordinator; Mr. Gary Koller, supervisor of the living collections; Mr. Carl Lobig, publications officer; Ms. Kate Nixon, public relations officer; Ms. Cornelia McMurtrie, volunteers coordinator; Dr. Carroll Wood; the director (*ex officio*); and Mr. Timothy Anderson, former director of the Franklin Park Zoo, who acted as the outside member.

Our programs are still at an early stage of expansion. In this light, the year's achievements are considerable.

It is our policy that the public programs of the Arnold Arboretum should be entirely funded by the revenue they produce. As part of the reorganization of our budget and financial systems, cost centers were established for the public programs, and subordinate centers for each of the sections, including publication, education, membership, exhibits, volunteers, and public information. It is now feasible to compare costs against revenue for each section quarterly and thereby to identify promising sources of revenue as well as unnecessary drains on



resources. In the process cost analyses of various operations became necessary. Analyses were undertaken of our fledgling internal transportation system and the unit cost of growing plants in the greenhouses. The latter aided efficiency in other parts of our program.

Public Facilities

The Arnold Arboretum in Jamaica Plain has lacked such basic public facilities as toilets, an information and sales room, and meeting rooms. Our single exhibition and lecture room was clearly inadequate to meet all needs. An architectural firm, Douglas Okun & Associates, was therefore commissioned to convert the front wings of the Hunnewell Administration Building on the first floor to public use. Work started June 1, 1981. The renovation will provide a lecture room, a seminar room, an exhibition area, receptionist space, a kitchenette, a sales shop, work space for volunteers, a lift for the handicapped, and men's and women's rooms designed for handicapped access, as well as offices for the Friends coordinator, plant information coordinator, and public relations officer. This project has been made possible in part thanks to grants from the Charles B. Hayden Foundation, the William E. and Bertha E. Schrafft Charitable Trust, the Neal Rantoul Foundation Trust, the Edwin S. Webster Foundation, and the Cabot Family Charitable Trust.

The five electric trams which were donated last year went into operation on July 7, 1980, when a Family Day was organized to give publicity. A tape was prepared for interpretive tours of the grounds. The trams were well received by the public; tours continued on weekends through the summer, and charter tours were organized on

From left to right: *Superintendent Henry Goodell organizes the removal of the electric trams which proved to be uneconomical, and too weak to climb hills at the Arboretum. Thanks to a generous gift, they will be replaced by a new gasoline powered bus. Photographs by C. Lobig.*

weekdays. The trams were plagued with breakdowns, however. The electric motors proved insufficiently strong to pull full loads up our hills. Further, the trams carried too few passengers to be economical. Regrettably, four had to be sold, one being kept as a mobile sales booth. A generous donation from Mrs. Barry Bingham has enabled us to acquire a new, gasoline-driven vehicle that can carry 25 passengers in comfort.

Much further thought has gone into future development of our public programs and services in the spirit of the policies defined in the previous two annual reports. A five-year program for all sections of our public services has been set up with a provisional time schedule to aid planning. Weekly meetings of the Public Relations and Education Committee have led to improved coordination. Integrated time-schedules were initiated in the current year and proved effective.

On January 8, 1981, a meeting was convened of representatives from the city of Boston, the Metropolitan District Commission, the Massachusetts Bay Transportation Authority, the Harvard administration, and the Arboretum to discuss the need for improved public facilities in Jamaica Plain. Our aim is to attract more visitors, who are themselves a safeguard against serious vandalism, and to generate revenue for the improvement of security and maintenance. Following this meeting, Environmental Planning and Design of Pittsburgh was commissioned to undertake a feasibility study to assess whether such a development would be financially viable. The conclusions of this study, completed at the end of March, were positive. The study recommended that revenue could be developed from internal transportation, parking facilities, and a visitor reception center with an exhibition space, an interpretive garden to which there could be an admis-

sion charge, a restaurant, and a sales area. Following further meetings, preparations are now being made to commission a detailed economic and market analysis of the alternatives open to us, on the basis of which a master plan will be prepared. Negotiations meanwhile continue with the MBTA, the MDC, and the city of Boston for a new access to the Arboretum from the proposed new subway station, across MBTA and city land into our South Street tract. All parties have agreed in principle to this proposal, and the engineers for the Southwest Corridor Project are designing the station surroundings in a manner which will accommodate a turning circle and roadhead for our internal transportation system. It has also been agreed that there will be an exhibition space within the station for the Arboretum. Our horticulture staff are assisting in the landscaping of the station precinct.

Horticultural Taxonomist Richard Weaver has been awarded a grant by the National Endowment of the Humanities for an interpretive guide to the Arnold Arboretum which will research our plant collection as a human endeavor. Horticultural Research Archivist Sheila Geary, Staff Assistant Ida Hay, and Volunteer June Hutchinson worked with Dr. Weaver in the preparation of the proposal.

Meanwhile, part of Mrs. Bingham's gift is to be used to design and install interpretive signs at key points of the Arboretum.

Public Relations

Ms. Hope Wise, public relations officer, who joined us July 1, 1980, resigned at the end of April. Her place has been taken by Ms. Kate Nixon. During her brief stay, Ms. Wise was responsible for planning and implementing our first newsletter, *plantSciences,* which was published in October; a second issue appeared in the spring, and a third will do so in July. It is intended that three will appear annually, to complement the annual report which is published in December. The newsletter communicates news of Harvard botany in general; it has been well received by both Friends and the general public.

Several other public relations projects were undertaken. A shuttle bus was organized to run from Harvard Square to the Arboretum on Sunday afternoons in May and proved extremely popular. With the collaboration of the propagation staff, a plant sale was held at the Case Estates in October following the annual plant distribution to Friends. It drew an unexpectedly large crowd and 41 new Friends. This is to become a regular event. Local community activities included a tree-planting ceremony on the grounds of the Little City Hall in Jamaica Plain, when three Japanese wingnut trees (*Pterocarya rhoifolia*), grown from seed collected by Drs. Spongberg and Weaver, were planted to commemorate Arbor Day; and a litter cleanup on Peters Hill in the Arboretum, which was undertaken by the Corporation for a Cleaner Commonwealth.

Wedding ceremonies have become increasingly popular in both Jamaica Plain and the Case Estates. The administration of requests for weddings and other receptions has been reorganized; they are providing a useful minor source of income.

Publicity for the Arboretum and its programs was increased considerably during the year. A public service announcement was produced with Channel 7. Slides of plants in bloom were sent to WGBH Television (Channel 2) and appeared periodically. A *Boston Globe* series on plants in bloom at the Arboretum was revitalized. There was increased publicity for all events, classes, courses, and tours, which undoubtedly contributed to their success. The course brochures, the work of Plant Information and Education Coordinator Eugenia Frey, were particularly admired, as was a four-page supplement in the *Gazette* which highlighted the Arboretum's spring program.

Internal communication has been much improved through inauguration of *The Sheet*, a news bulletin which provides staff in Weston, Cambridge, and Jamaica Plain with news of current activities.

Public Education and Information

Thanks in part to increased experience with the interests of our public, and in part to much-improved publicity, there was greatly increased participation in our course program, especially from the Cambridge community. The series in Weston was moved this year to the Harvard University Herbaria Building in Cambridge, and from weekday to weekend and evening programming. Owing to renovation work in the Hunnewell Building, spring programs in Jamaica Plain took place in the Dana Greenhouse classroom. Besides publicity from *plantSciences*, news releases, fliers, and the *Harvard University Gazette*, the spring program brochure was designed in a poster format. This led to increased distribution, and extra runs of the poster were sold in the Harvard Coop.

Attendance increased from averages of 25 last year to 60 at the end of this year. Twenty-four programs, of which 5 were cancelled owing to inadequate registration, were organized for fall, 1980; thirty-three programs of which 8 were cancelled were organized for the spring, 1981. Total attendance jumped to 219 in the fall, and to 576 in the spring, representing increases over the previous year of 28 percent and 56 percent, respectively.

Altogether, 17 staff from all sections of the Arboretum and the Department of Organismic and Evolutionary Biology, 10 graduate students, and 11 outside speakers contributed to the programs. The interest and enthusiasm shown by staff and students alike is very encouraging.

This year pilot programs were run for elementary school children. The Park School and the Milton School, grades 4 and 5, participated. These sessions are beginning to give us information for curriculum and program development for future school programs.

An improved educational program was offered to our summer horticultural trainees, with Tuesday lunchtime talks, Thursday afterwork walks, and weekend trips with staff. We received 72 applications this year, of which 19 were accepted from 10 states, including 10 from Massachusetts.

Owing to building renovation only three exhibits were mounted this year in the Hunnewell Building. The first, "The Herbarium," prepared by Ms. Ida Hay, ran between July and September and explained the purpose and methods of herbaria. Between September and November the work of a young watercolor painter, Ellen Tikkanen, was exhibited in a show entitled "Arnold Arboretum Landscapes." "Conifers," an exhibit assembled after considerable careful research by Volunteer Richard Warren, was on view from November to February. Our exhibit at the Massachusetts Horticultural Society Spring Flower Show was entitled "Oriental Temple Garden." An enormous amount of staff time went into its preparation, and this was rewarded with a Gold Medal, the First Prize for the horticultural merit of the plants, and the prestigious Trustees Emeritus Award for an innovative exhibit which most exemplifies and expands the traditions of the show. A major effort was put into distributing 10,000 Arnold Arboretum pamphlets, yet only 200 were returned. Clearly, we must review the benefits of the considerable effort involved. Thanks to the excellent coordination of our volunteers coordinator, Ms. Cornelia McMurtrie, we were able to increase the number of guided tours of the Arboretum substantially in 1981, and they have become a significant source of revenue. Altogether, 65 guided tours, led by staff and 17 volunteer guides, took place at the Arboretum and the Case Estates in the spring, 1981. A week-long orientation and training session for new tour guides was held in April, 1981.

The heaviest attendance of visitors on tours was during the week of May 18, following "Lilac Sunday," with 10 scheduled and approximately 30 unscheduled tours. An exact count of groups visiting the Arboretum proved impossible, but a typical busy day, May 21, witnessed 8 unscheduled tour buses and walks in addition to the 5 scheduled guided tours. In a typical week in early June, 38 driving permits were issued to residents of 12 states, including Idaho, California, Texas, Georgia, and Kansas. Although the number of cars has been kept under control, an even greater effort should be made to reduce the number of cars driving within the Arboretum.

The plant information service has been increased in efficiency by implementation of a one-hour daily "hotline" service. This has proved convenient for staff and users alike and will improve further with the completion of the new telephone system in Jamaica Plain. Ms. Frey, Ms. Hay, Mr. Koller, Mr. Alexander, and Dr. Weaver are the principal contributors. In the fall, 1980, Ms. Linda Bowman volunteered to provide the service, which proved very helpful. There were 1,086 recorded inquiries between July, 1980, and May, 1981, of which about 350 were poison calls, and a similar number addressed cultural ques-

Above: *Lilac Sunday was a beautiful, sunny day, and many visitors turned out to enjoy the sights.* Below: *One of the trams was converted into an information booth, manned by the staff on Lilac Sunday. Photographs by R. Weaver and C. Lobig.*

tions. Many inquiries are of a specialized nature, and it has been found necessary to build up a reference book collection for rapid access to answers.

The community gardens project continued to be plagued by vandalism, and the drought in 1980 proved a further detraction. In the spring, 1981, registrations for plots had dropped to half that of the previous year. It was decided that more people were needed to carry out all jobs required for adequate garden maintenance, though committees were established and workdays organized.

Volunteers

Ms. Cornelia McMurtrie became part-time volunteers coordinator on a trial basis in January, taking over responsibility for the program from Ms. Hope Wise. She proved extremely successful.

New volunteers were attracted to the Arboretum by the offer of membership benefits and by expanded publicity. Contacts were also made with local volunteer organizations.

The contribution of the volunteers to the activities of the Arboretum has been considerable. During the year 67 volunteers have donated their time, 42 of them on a regular basis, for an average of 120 volunteer hours a week. Since the 1981 training session, 13 new volunteers have joined the staff. Many projects would not have been accomplished without the help of our volunteers. Highlights of the year's achievements include the following:

Over a six-week period 17 volunteers, 10 of them new, led 65 tours, generating $1,300 in revenue; volunteer landscape designers completed the research, map, and graphics for a guide to the Case Estates, and an extensive nursery index; a landscape architect has volunteered to help produce a slide show for use in community programs; one volunteer is organizing our large photograph collection.

A team, which includes conifer and rhododendron authorities and a plant ecologist, is assisting in the verification of the living collections; one volunteer, working full-time, aided by a team of three others part-time, is making reference vouchers from the living collections which will be housed in our herbarium of cultivated plants; duplicates are being collected for exchange. Altogether, seven volunteers have contributed to this collecting program.

Supervisor Gary Koller has had the assistance of two volunteers in the assessment of our shrub collections; volunteers have assisted Mr. James Burrows in the renovation of the rock garden and the development of the American Garden at the Case Estates; one volunteer assisted in preparation of a grant proposal for curatorial assistance for the slide collection, another in the grant proposal for the guidebook to the Arboretum; bilingual volunteers have translated publicity material for the Arnold Arboretum into French and Spanish.

Volunteers prepared the spring *plantSciences* mailing and collated 10,000 handouts for the Massachusetts Horticultural Society's New

England Spring Flower Show. Fifty volunteers took turns in manning our exhibit for the ten-day show; volunteers staffed the Fall Plant Distribution and Sale at the Case Estates.

The ranks of the greenhouse volunteers have expanded to 12, transplanting many thousands of seedlings for the 1982 plant mailing to Friends, compiling inventories, and processing seeds.

In all, this is a remarkable contribution, deserving our deepest thanks. Special recognition must go to Mr. Al Bussewitz, who taught classes, has assisted almost every staff member in Jamaica Plain, and who also led innumerable tours, including one which was unique for the Newton Center for the Blind.

Membership

Our total membership at the end of the year was 2,366, representing a net increase of 118. This is considerably less than we had planned, but plans for a membership drive were delayed until *Arnoldia,* which has been behind schedule, is up to date.

Nevertheless, staff, with the help of volunteers, have been working hard to reach new sources through mailings. We are proud of the results from mailings to past deleted members: 6.8 percent of these former Friends were welcomed back. Since we know that mailings have been successful it is obvious that some computerized means must be utilized for membership acquisition in the future. With *Arnoldia* back on schedule a major campaign to increase membership will be undertaken in the coming year.

The Friends' benefits have increased this year with the introduction of the Arboretum's new newsletter, *plantSciences,* which will enable Friends to keep in touch with current Arboretum activities and accomplishments.

In accordance with past policy, course and workshop participation was offered to Friends at reduced rates. Special invitations were sent to Friends for openings of two of our exhibits, "Arnold Arboretum Landscapes" by Ellen Tikkanen, and "Conifers" by Dr. Richard Warren.

All Friends received invitations to Family Day, which was held on July 7 at the Arboretum. Included in the invitation were tickets for a free tram tour of the Arboretum.

The Friends' plant distribution was held on Sunday, September 28, at the Case Estates in Weston. Surplus plant material was distributed to over 200 attending members.

Friends responded enthusiastically to the lecture series "Oriental Connection." In conjunction with this a special offer was made to Friends who brought in new members. Both the sponsor Friend and the new Friend were given a choice of a gift plant of oriental origin, or free tickets to a lecture in this series.

Spring walks for new members were held on both May 28 and May 30. New members were welcomed by the director, and seasoned

volunteer guides Mrs. Cora Warren and Mr. Al Bussewitz gave special tours.

In order to show our appreciation to our sponsors, donors, and patrons, a reception was held in their honor in the Hunnewell Building Lecture Hall on October 16.

GIFTS

The Arnold Arboretum was fortunate to receive several gifts this year which will substantially aid our research as well as our public programs. Thanks to an anonymous donor, we have been enabled to equip one of the laboratories in the greenhouse/headhouse with the basic facilities required for chemosystematic research, which is the study of patterns of variation in plants based on their chemical constitution. This is an area which can particularly benefit from our living collections, yet one which we have not previously been in a position to foster.

Geoffrey Nolin's research into the genera *Alnus* and *Ceanothus*, with the ultimate aim of assessing their value as forage, has been made possible by a gift from the Percy Selden Fund.

An arcto-tertiary garden is in the process of being installed below the Oak Path at the base of Bussey Hill. This planting, which will interpret the plant geographical connections between the eastern United States and East Asia, a continuing interest of Harvard botanists from the time of Asa Gray, is a gift of Mr. Paul Hofer in memory of Mrs. Frances Hofer, his wife. This represents the second endowment towards our goal of restoring and maintaining the original grass path system, with associated wild flower plantings, in the Arboretum.

The Arnold Arboretum also received a generous gift from Mrs. Barry Bingham, Jr., to enhance our public programs. This will be used to acquire a bus, seating twenty-five passengers, and towards the installation of interpretive signs at the main entrances and at entrances to major collections on the grounds.

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Appendix: Weather Station Data for 1980

	Avg. Max. Temp. (°F)	Avg. Min. Temp. (°F)	Avg. Temp. (°F)	Extreme Max. (°F)	Extreme Min. (°F)	Precipitation (inches)	Snowfall (inches)
Jan.	36	20	28	57	6	.73	.3
Feb.	36	16	26	56	5	.90	4.8
Mar.	45	28	37	63	3	5.80	3.0
Apr.	58	40	49	76	29	4.50	—
May	69	48	59	90	37	1.83	—
June	79	53	66	96	40	3.82	—
July	86	63	75	99	51	3.01	—
Aug.	85	63	74	97	51	1.43	—
Sept.	79	53	66	97	36	.80	—
Oct.	62	39	51	78	26	4.58	—
Nov.	49	31	40	63	21	3.37	4.0
Dec.	37	16	27	60	−10	1.02	6.2

Average maximum temperature	60°
Average minimum temperature	39°
Precipitation	31.79″
Snowfall	18.3″
Warmest temperature	99° on July 21
Coldest temperature	−10° on December 26
Date of last frost	April 18
Date of first frost	October 14
Growing season	179 days

Weather Station Data for the First Six Months of 1981

	Avg. Max. Temp. (°F)	Avg. Min. Temp. (°F)	Avg. Temp. (°F)	Extreme Max. (°F)	Extreme Min. (°F)	Precipitation (inches)	Snowfall (inches)
Jan.	30	10	20	49	−7	.99	10.8
Feb.	44	26	35	68	6	7.89	3.0
Mar.	46	29	38	76	16	.70	—
Apr.	63	39	51	77	25	3.32	—
May	72	47	60	90	33	2.21	—
June	80	57	69	93	48	2.21	—

Average maximum temperature	56°F
Average minimum temperature	35°F
Precipitation	17.32 inches
Snowfall during winter 1980–1981	24.0 inches
Continuous snow cover winter 1980–1981	December 16, 1980–February 1, 1981
Warmest temperature	93° on June 17
Coldest temperature	−7° on January 5
Date of last frost in spring	April 23
Continuous freezing temperature	January 9–19, 1981

JOHN H. ALEXANDER III

Appendix: Status of Staff Members of the Arnold Arboretum 1 July, 1980–30 June, 1981

New	Date Hired	Position
Susan Bryant	Jan., 1981	Staff Assistant
Mary Byrnes	Sept., 1980	Secretary
Barbara Callahan	March, 1981	Librarian of the Arnold Arboretum and Gray Herbarium*
Patricia Dalton	April, 1981	Curatorial Assistant
Katherine Grant	Feb., 1981	Secretary
Carl F. Lobig	Sept., 1980	Publications Officer
Margaret van Montfrans	Jan., 1981	Botanical Illustrator
Kathleen Nixon	Jan., 1981	Public Relations Officer
Helen Shea	Dec., 1980	Secretary
Franklyn Stevens	Oct., 1980	Administrative Officer
Benjamin Stone	March–July, 1980	Mercer Fellow
Mary Thomas	August, 1980	Library Assistant*
Hope Wise	July, 1980	Public Relations Officer

Resigned	Date	Position
Norton Batkin	Aug., 1980	Publications Officer
Kristin Clausen	Aug., 1980	Research Assistant
Marylinda Coyne	Nov., 1980	Secretary
Leonore Dickinson	March, 1981	Librarian of the Arnold Arboretum and Gray Herbarium*
Christian Fraza	Dec., 1980	Library Assistant
Lisa Frost	July, 1980	Secretary
Ann Johnson	Sept., 1980	Secretary
Margaret Quinn	Nov., 1980	Secretary
C.-Jeanne Stevens	Aug., 1980	Library Assistant*
Dorothea Talbot	Dec., 1980	Secretary
Mia Touw	Feb., 1981	Research Assistant
Hope Wise	March, 1981	Public Relations Officer

Continuing Employees	Position
John H. Alexander, III	Plant Propagator
Vincent T. Antonovich	Grounds Staff
Peter S. Ashton	Director, Arnold Professor of Botany, Professor of Dendrology
Ralph J. Benotti	Grounds Staff
James A. Burrows	Assistant Supervisor of the Living Collections
Michael A. Canoso	Manager of the Systematic Collections of the Arnold Arboretum and the Gray Herbarium*
Luis Colon	Grounds Staff
Peter J. Del Tredici	Assistant Plant Propagator
Barbara O. Epstein	Friends Coordinator

Robert E. Famiglietti	Grounds Staff
Helen M. Fleming	Herbarium Preparator
Eugenia Frey	Plant Information Coordinator
Sheila C. Geary	Assistant Librarian
Henry S. Goodell	Superintendent of Buildings and Grounds
Michael A. Gormley	Grounds Staff
Dennis P. Harris	Grounds Staff
Ida Hay	Staff Assistant
Richard A. Howard	Professor of Dendrology
Thomas M. Kinahan	Superintendent of the Case Estates
Walter T. Kittredge	Curatorial Assistant*
Gary L. Koller	Supervisor of the Living Collections
Nancy A. LeMay	Secretary
Charles J. Mackey	Grounds Staff
Wendy Marks	Manager of Public Services
Norton G. Miller	Botanist
Bruce G. Munch	Grounds Staff
Robert G. Nicholson	Grounds Staff
James M. Nickerson	Grounds Staff
Timothy O'Leary	Grounds Staff
James Papargiris	Grounds Staff
Elizabeth B. Schmidt	Managing Editor, *The Journal of the Arnold Arboretum*
Bernice G. Schubert	Senior Lecturer in Biology, Curator of the Arnold Arboretum
Maurice C. Sheehan	Grounds Staff
Anne M. Sholes	Herbarium Preparator
Colleen Sliney	Herbarium Secretary*
Stephen A. Spongberg	Horticultural Taxonomist, Editor, *Journal of the Arnold Arboretum*
Peter F. Stevens	Associate Professor of Biology, Associate Curator of the Arnold Arboretum and the Gray Herbarium,* Supervisor of the Combined Herbaria*
Mark A. Walkama	Grounds Staff
Peter Ward	Grounds Staff
Richard E. Weaver, Jr.	Horticultural Taxonomist
J. Patrick Willoughby	Assistant Superintendent of Buildings and Grounds
Carroll E. Wood, Jr.	Professor of Biology Curator of the Arnold Arboretum
Donald Wyman	Horticulturist Emeritus

* Joint appointment of the Arnold Arboretum and the Gray Herbarium.

Appendix: Plants Celebrating their Centennial the Arnold Arboretum 1881–1981

Acer pensylvanicum	12532-C
Acer pensylvanicum	12533-C
Acer saccharinum	12560-A
Acer saccharinum	12560-B
Acer saccharinum	12560-C
Celtis laevigata var. smallii	1165
Chamaecyparis obtusa var.	13038-B
Chamaecyparis obtusa var.	13038-C
Chamaecyparis obtusa var.	13038-D
Chamaecyparis pisifera cv. filifera	13045-A
Chamaecyparis pisifera cv. filifera	13045-B
Cladrastis lutea	13055-B
Elaeagnus multiflorus	1136-3-A
Elaeagnus multiflorus	1136-3-B
Fraxinus quadrangulata	14654-A
Fraxinus quadrangulata	14654-B
Fraxinus quadrangulata	14654-K
Gleditsia triacanthos	22514
Hydrangea heteromalla var. glabrescens	518
Larix occidentalis	1559-A
Lonicera japonica cv. halliana	953-1
Parrotia persica	2230
Philadelphus x falconeri	15345
Picea abies	1562
Pinus parviflora	1421-A
Syringa emodi	6628
Thuja occidentalis cv. pumila	17420-B
Tsuga canadensis cv. compacta	1680
Tsuga canadensis cv. pendula	1514-2
Zenobia pulverulenta	1714

ANNOUNCING

A special event in conjunction with the *Arnoldia* issue of Spring 1982:

"Dutch Elm Disease: A Symposium on Causes and Cures"

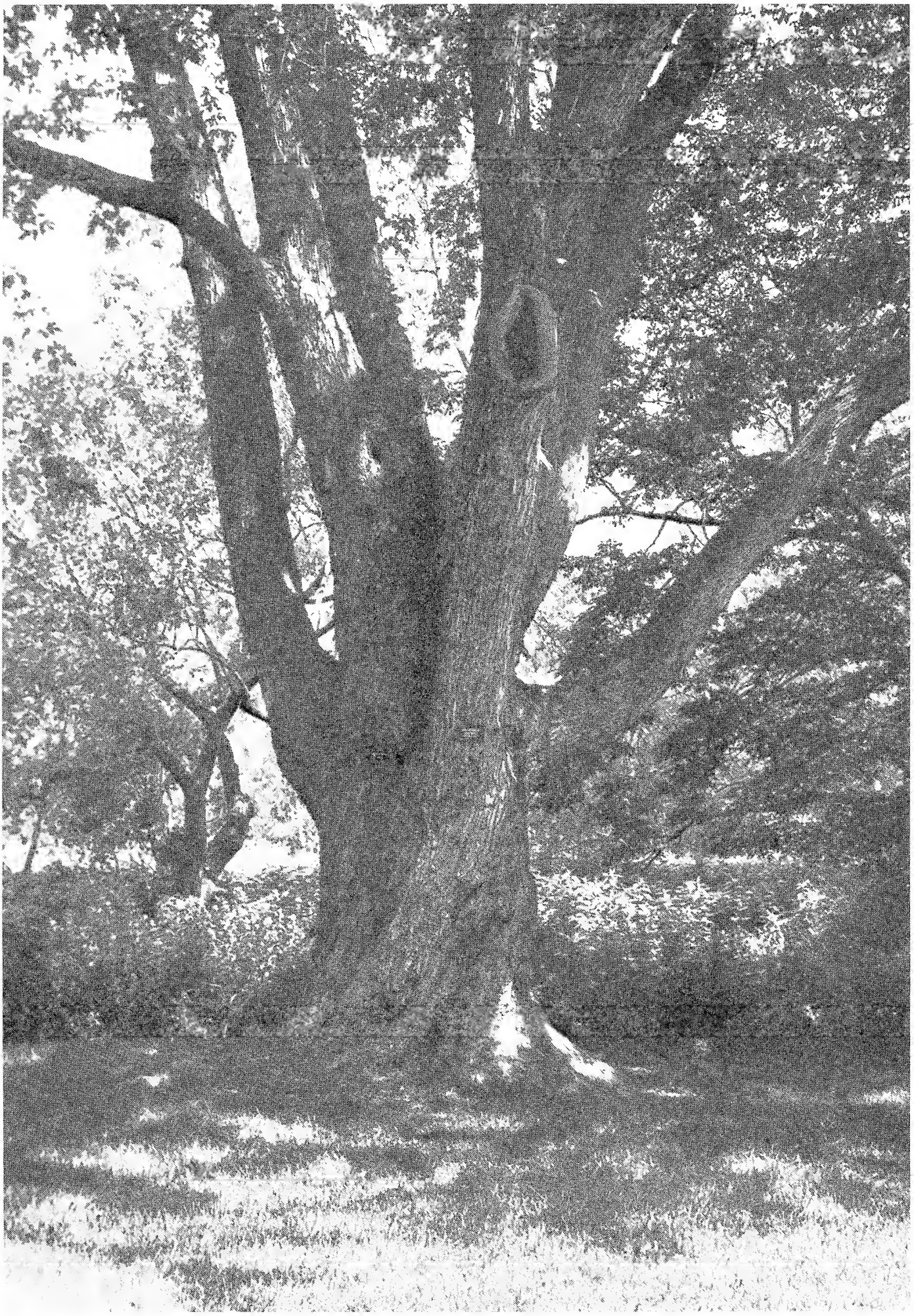
Presented by
Martin Zimmermann, Director of the Harvard Forest
and
Dennis Newbanks, Plant Pathologist

April 22, 1982

6:30–7:00 p.m.: Meet the speakers and enjoy refreshments
7:00–8:00 p.m.: Lecture and discussion, Dr. Zimmermann
8:00–9:00 p.m.: Lecture and discussion, Dr. Newbanks

at the Hunnewell Building of the Arnold Arboretum

Fee: $10.00 (members), $12.00 (nonmembers)
Payable at the door or by advance registration.
Call 524-1718 for details and registration.



The trunk of one of the trees at the Arnold Arboretum celebrating its centennial this year—a fine silver maple (Acer saccharinum) *along Meadow Road. Photograph by C. Lobig.*

Index to Volume 41